Chapter 7: Launch, Flight Maneuvers, Landing, & Recovery Procedures

Introduction

In the early days of soaring, a crew might launch a glider from the top of a hill using a bungee cord. With the tail of the glider tied down, the ground crew would attach the center of a bungee cord to a hook on the nose of the glider. Members of the ground crew stretched the separate ends of the bungee cord ahead, into the wind, and offset from the glider. With sufficient tension on the bungee cord and upon release of the tail tie-down, the glider would accelerate as if launched from a slingshot.

As gliders got larger, pilots looked for better ways to launch. Enthusiasts began using cars to pull gliders. Over time, powered winches and airplane towing became preferred launching methods. This chapter discusses glider launch techniques and procedures as well as takeoff procedures, traffic patterns, flight maneuvers, and landing and recovery procedures.

Glider pilots should understand risks associated with the large wingspan of a glider and ground operations. The wings can strike runway lights and other obstructions near the runway during reposition, takeoff, or landing. Impact with a wingtip could lead to ground loops during takeoff or landing. A cartwheel could occur if a wingtip strikes the ground before the glider touches down, leading to extensive damage and serious injury. Training, pilot proficiency, hazard consideration, and risk mitigation before and during flight reduce the likelihood of these undesirable events.

Aerotow Takeoff Procedures

Signals

Visual signals enhance communication and coordination between the glider pilot, the pilot of the towing aircraft, and the ground crew.

Prelaunch Signals

Aerotow prelaunch signals facilitate communication between pilots and launch crewmembers/wing runners when preparing for the launch. *Figure 7-1* illustrates these hand signals. The raise wingtip to level position is given by the pilot.

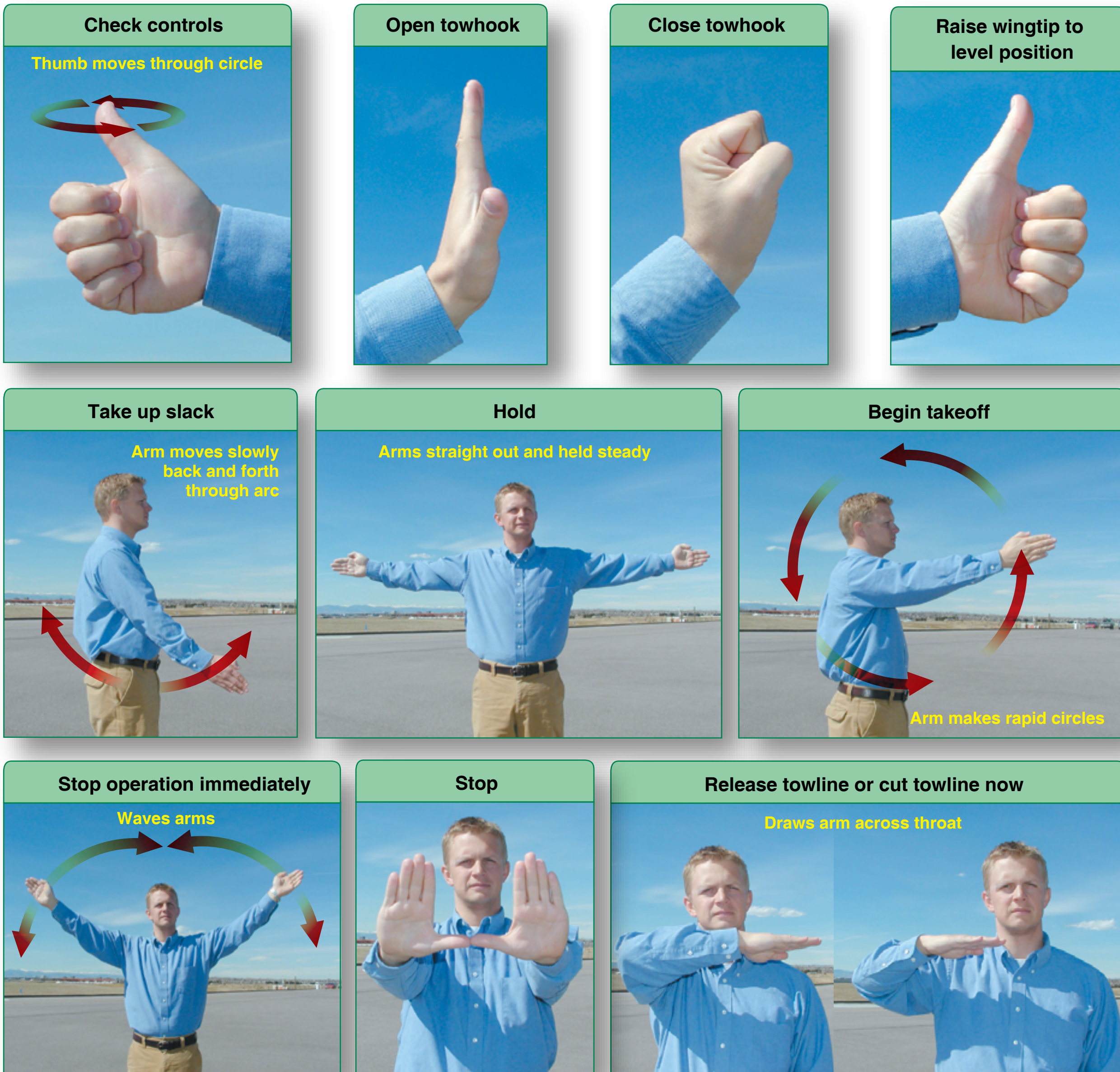

Figure 7-1. *Aerotow prelaunch signals.*

Inflight Signals

When airborne, pilots use the flight controls to create visual signals that allow the tow pilot and the glider pilot to communicate. The signals divide into two types: those from the tow pilot to the glider pilot and signals from the glider pilot to the tow pilot. *Figure 7-2* depicts these signals.

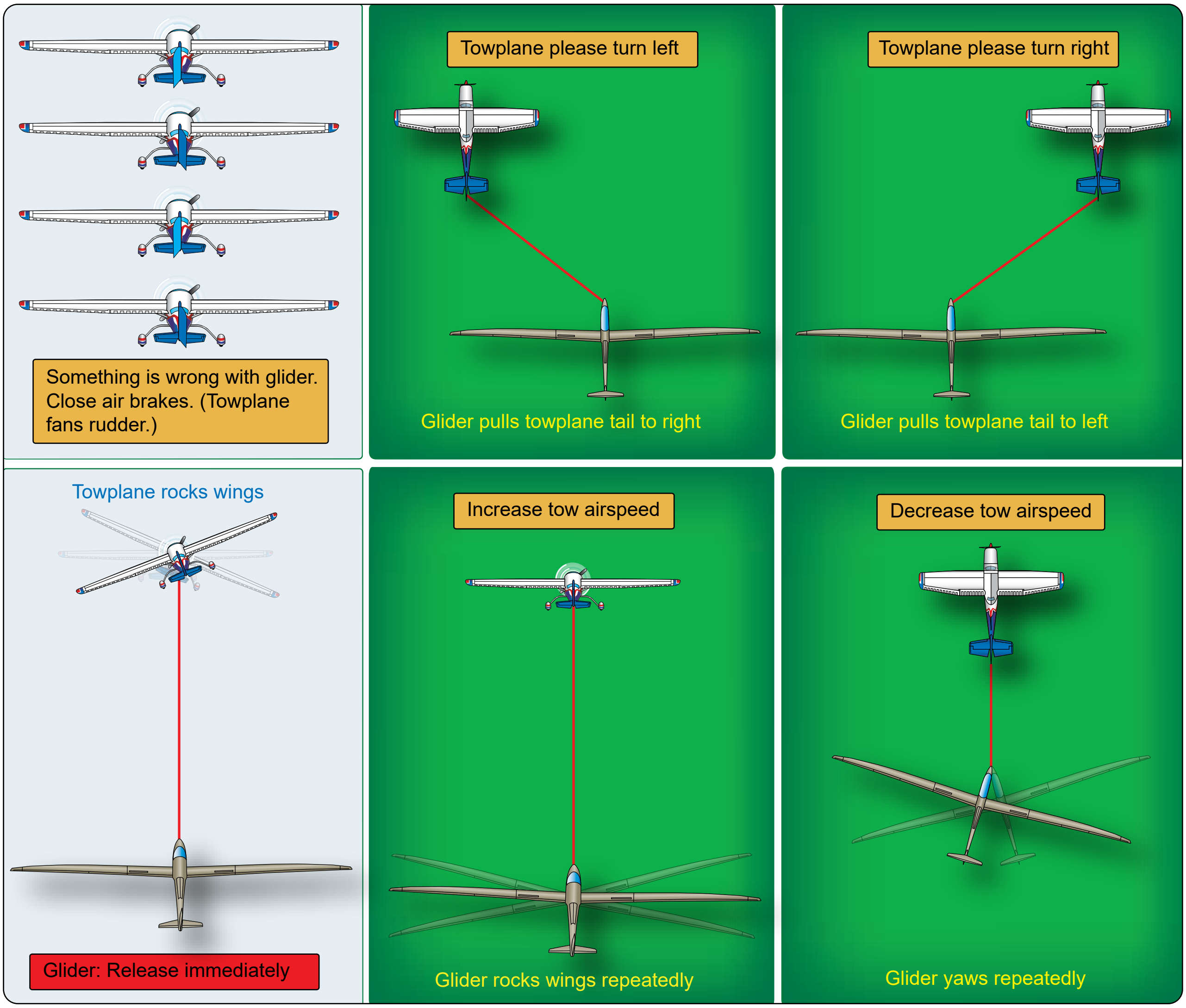

Figure 7-2. *Inflight aerotow visual signals.*

The tow pilot could use the aerotow signals shown in the two panels on the left side of *figure 7-2* when close to the ground. The glider pilot should know how to differentiate between these signals to avoid an unnecessary release close to the ground. Even with two-way radio in both aircraft, radio communications could distract either pilot when operating near the ground and could increase risk of loss of control.

The two green panels of the top row of *figure 7-2* illustrate how a glider pilot requests a turn. Since large or abrupt lateral offset has the potential to interfere with tow-plane control, glider pilots should only use lateral offset signals as depicted in at or above 1,000 feet AGL.

The two green panels of the bottom row of *figure 7-2* illustrate how a glider signals for a change in speed when at or above 1,000 feet AGL. The glider pilot yaws repeatedly or rocks the wings as depicted, and the force on tow line oscillates and causes a series of small accelerations and decelerations. Signaling in this manner should get the attention of the tow pilot who then can look back and interpret the signal.

Takeoff Procedures & Techniques

Takeoffs benefit from a crewmember on the ground who can scan for traffic and provide general assistance during the takeoff. An assisted takeoff includes a crewmember or wing runner who maintains the glider wing in a level position as the glider begins its takeoff roll. An unassisted takeoff does not include a wing runner or other ground crew. Glider and tow pilots should only perform an unassisted launch if trained on the procedure and if conditions allow for a safe unassisted takeoff. An unfamiliar glider or lack of proficiency adds the risk of this type of takeoff.

Prior to takeoff, the tow pilot and glider pilot should agree on a plan for the aerotow. The glider pilot should also ensure the launch crewmember has sufficient knowledge of the plan. Some items to consider include the intended ground path, pattern clearing procedures, and glider configuration checks (spoilers closed, tailwheel dolly removed, canopy secured). Takeoffs normally occur into the wind.

Connecting the tow line to a glider in preparation for takeoff should only occur with the glider pilot aboard and ready for flight. The launch crewmember presents the tow rope end to the pilot so the pilot can ensure it is in good conditions and with the correct ring and weak leak, if required. When the required checklists have been completed with both the glider and towplane ready for takeoff, the launch crewmember/wing runner starts to hook the towline to the glider. If the pilot exits the glider for any reason, the pilot or launch crewmember should disconnect the towline to prevent accidental tow of an unoccupied glider.

Normal Assisted Takeoff

A deliberate tow rope hookup should occur, which includes a check of the release mechanism for proper operation. The launch crewmember should apply tension to the tow line and signal the glider pilot to activate the release. The launch crewmember should verify that the release works properly and communicate that information to the glider pilot. With the tow line again hooked up to the glider, the launch crewmember moves to the wingtip on the ground and clears both the takeoff and landing areas.

When the glider pilot signals the launch crewmember at the wingtip to lift the wing, that crewmember picks up and holds the wing in a level position and signals the tow pilot to “take up slack” in the tow line. With the slack out of the tow line, the glider pilot signals ready for takeoff by wagging the rudder, and the crewmember simultaneously signals the tow pilot for takeoff. If using a radio, the glider pilot could indicate the takeoff signal to the tow pilot by stating, “Canopy locked and ready for takeoff.”

As the aerotow begins and the glider accelerates, the launch crewmember runs alongside the glider, holding the wing in a level attitude until the glider pilot gains roll control or the speed of the glider exceeds the crewmember's safe running speed. An increase in resistance to aileron movement indicates aileron effectiveness. Holding the wings level with the ailerons may require full deflection of the flight controls until sufficient airspeed increases effectiveness of the controls.

Risk of collision with runway lights, signage, and other obstructions alongside the runway during the takeoff roll increases due to the combination of long wings and short landing gear when compared to airplanes. The pilot can mitigate this risk by steering the glider solely with the rudder so as not to have one wing low. [*Figure 7-3*]

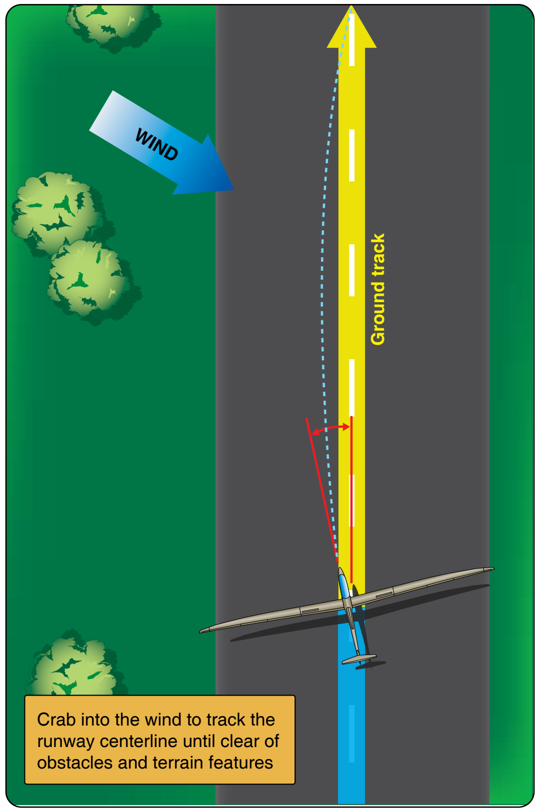

Figure 7-3. *Tracking the runway centerline.*

When the glider achieves lift-off speed, the glider pilot should maintain the glider at a low altitude of 2 to 4 feet—the exact altitude depends on the specific glider. As the glider and tow plane accelerate, the glider pilot should maintain altitude by applying stick pressure, as necessary. If the glider climbs above the towplane's tail
during the takeoff, tension on the towline pulls up on the towplane tail and could force the towplane's propeller into the runway surface. Once lift-off occurs and since lateral deviation can force the towplane off the runway, the glider pilot can use coordinated aileron and rudder to remain directly behind the tail of the towplane.

During most takeoffs, the glider achieves flying airspeed before the towplane. In this case and once the towplane lifts off, it accelerates in ground effect to the desired climb airspeed, and the climb begins for both the towplane and glider. However, a glider loaded with ballast might not achieve liftoff airspeed before the towplane. In this situation, the towplane should remain in ground effect until the glider becomes airborne.

Unassisted Takeoff

The unassisted takeoff begins with the glider positioned slightly off the runway heading (runway centerline) by approximately 10–20° with one wing on the ground. If the glider is canted to the right, then the left wing should rest on the ground. If canted to the left, the right wing should rest on the ground. When ready for takeoff, the glider pilot advises the tow pilot either by radio or by signaling the tow pilot with the "ready for takeoff" rudder waggle signal. As the towplane accelerates, the wing on the ground accelerates at a slower rate due to the increased drag due to the ground contact. This imparts a yawing motion that will help straighten out the glider. The pilot should use rudder to raise the lower wing until sufficient speed is obtained to allow aileron control of the bank angle. If the glider begins the takeoff roll aligned with the towplane during the takeoff, the wing on the ground tends to drag and severe swerving or a ground loop becomes more likely.

Crosswind Takeoff

Most gliders have a crosswind limit up to approximately 10–12 knots. Pilots should refer to the Glider Flight Manual/ Pilot's Operating Handbook (GFM/POH) for model specific information.

Crosswind takeoff procedures compensate for the following:

1. The glider tends to weathervane into the crosswind with the weight on the main wheel.

2. After lift-off, the glider tends to drift off the runway centerline with the crosswind.

Assisted

Prior to takeoff, the glider pilot should direct the launch crewmember to hold the upwind wing slightly low during the initial takeoff roll. In a crosswind, the pilot should hold full aileron into the wind as the takeoff roll begins. The pilot maintains this control position while the glider accelerates until the ailerons become effective. At the same time, the pilot uses downwind rudder to maintain a straight takeoff path and offset any tendency to weathervane while on the ground. [*Figure 7-4*] Note that takeoff using a CG hook makes the glider more sensitive to crosswind forces as there is no force from the tow line acting to keep the nose of the glider aligned with the direction of motion.

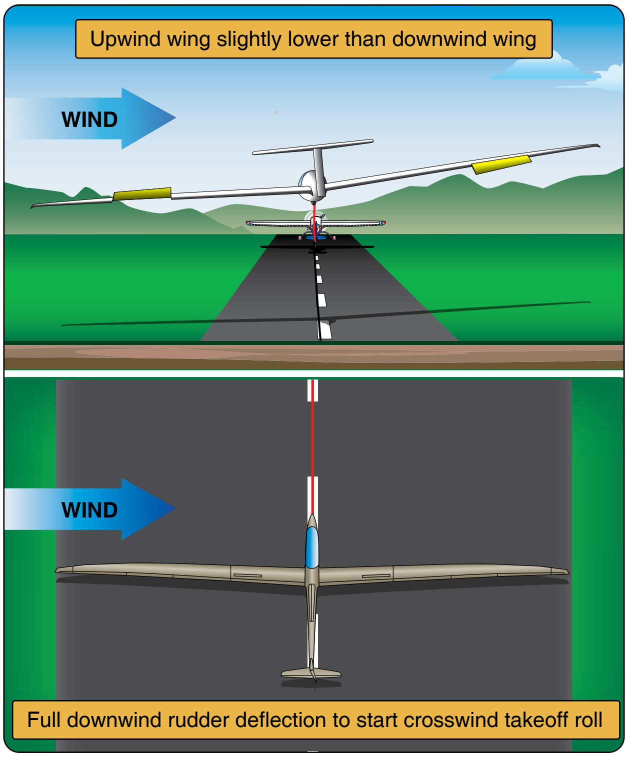

Figure 7-4. *Crosswind correction for takeoff.*

As the glider's forward speed increases, the crosswind becomes more of a relative headwind, and the pilot reduces the application of aileron into the wind. However, the pilot maintains sufficient aileron pressure throughout the takeoff roll to prevent the crosswind from raising the upwind wing.

If the upwind wing rises and exposes more wing surface to the crosswind, a skipping action or series of small bounces may result as the glider begins to fly and then settles back onto the runway. This side skipping imposes side loads on the landing gear. If the downwind wingtip touches the ground, the resulting friction may cause the glider to yaw in the direction of the dragging wingtip, which could lead to a loss of directional control and runway departure.

While on the runway during takeoff, the glider pilot uses rudder to control direction and alignment behind the towing aircraft. The pilot should avoid yawing back and forth behind the towplane, as this affects the ability of the tow pilot to maintain control. If glider controllability becomes a problem, the glider pilot should release and stop the glider on the remaining runway. In this case as the glider slows, the crosswind may cause the glider to weathervane.

After becoming airborne, but before the towplane lifts off, the glider pilot should maintain the crosswind correction to remain behind the towplane. Once the towplane becomes airborne and is clear of obstacles, the glider pilot repositions as needed to align behind the towplane.

Unassisted

Experienced pilots may consider using an unassisted crosswind launch procedure. An unassisted crosswind takeoff uses different wing positioning and glider alignment. The crosswind strikes the fuselage of the glider, tending to push it downwind, making it necessary to position the glider on the upwind side of the runway. If unable to offset, the towplane pilot may angle into the wind to reduce the crosswind component for the glider.

The glider should rest offset on the runway with the downwind wing on the ground and the glider angled approximately 20–30° into the wind. [*Figure 7-5*] As in a normal unassisted takeoff, the drag on the downwind wing imparts a yawing moment that swings the upwind wing forward at a faster rate than the downwind wing, aiding the pilot in leveling the wings. If the pilot begins the takeoff run with the downwind wing on the ground, a ground loop may result since the downwind wing will drag along the ground. The pilot should execute crosswind takeoff procedures as described above once the upwind wing rises and maintain a normal position directly behind the towplane.

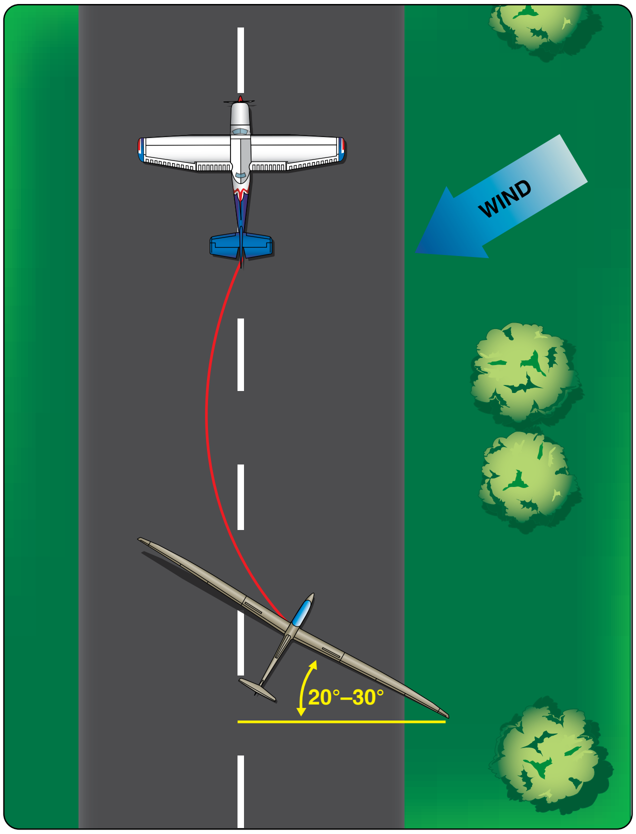

Figure 7-5. *When setting up for a crosswind takeoff, the glider should start on the upwind side of the runway.*

Pilot Induced Oscillations (PIOs) During Launch

During the first moments of the takeoff roll, as airflow begins to impact the control surfaces, it takes considerable displacement of the flight controls to affect the glider's flightpath. The pilot also experiences a higher control lag time due to reduced control effectiveness at low speed. As the glider accelerates, aerodynamic response improves, lag time decreases, and PIOs become less likely.

Several pilot techniques reduce the likelihood and severity of PIOs during aerotow launch. A pilot should not attempt to lift off until the glider responds sufficiently to aerodynamic control. Just after the moment of lift-off, the pilot should bring the glider to two to four feet above the runway to prevent ground contact from any minor excursion in pitch attitude. [*Figure 7-6*]

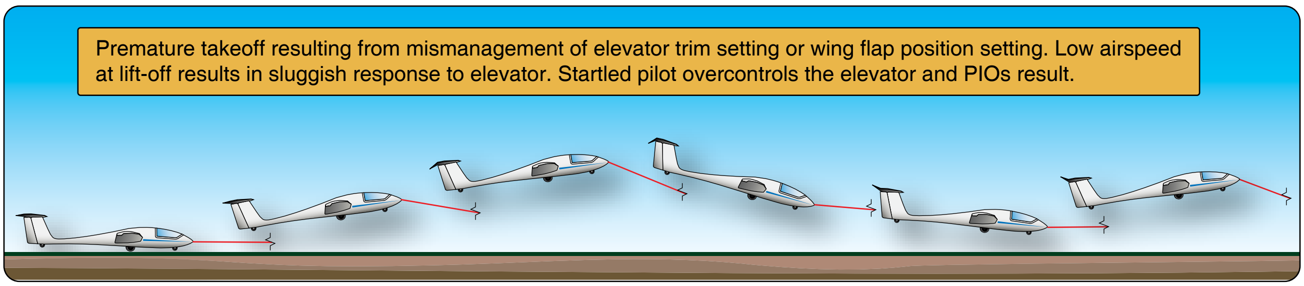

Figure 7-6. *Premature takeoffs and PIOs.*

Improper Elevator Trim Setting and PIOs

Gliders with an aerodynamic elevator trim tab or an anti-servo tab on the elevator may experience more challenging control issues when improperly trimmed. Pilots find that a simple spring-system elevator trim tends to help prevent PIOs, but they can still occur.

Improper Wing Flap Setting and PIOs

With an incorrect positive flap setting, the glider may lift off the runway prematurely. In response, the pilot exerts forward pressure on the controls and exerts an increasing nose-down force on the glider. When the glider eventually pitches down, the pilot may exert considerable back pressure on the stick to arrest the descent. A cycle of PIOs could result, which could lead to hard contact with the runway surface, glider damage, and personal injury.

An incorrect negative flap setting decreases wing camber and wing lift, and the glider may remain on the runway even after the tow plane lifts off and begins to climb out. The pilot may exert significant back pressure on the control stick to lift off, and ballooning may occur as the elevator becomes more effective. A series of PIOs may result, which could require termination of the tow to prevent ground contact or tow plane loss of control.

Gust Induced Oscillations

Gusty headwinds may induce pitch oscillations due to changes in the speed of the airflow over the elevator while crosswind gusts can induce yaw and roll oscillations. In gusty crosswinds, the effects on glider control change rapidly depending on the speed and angle of the crosswind component.

Nearby obstacles, such as hangars, trees, or hills and ridges can affect low altitude winds, particularly on the downwind side of the obstruction. In general, an upwind obstacle induces additional turbulence and gustiness in the wind. Pilots may encounter these conditions from the surface to an altitude of 300 feet or more. If flying in these conditions, the pilot should use a faster-than-normal speed prior to lift-off.

The additional speed increases the responsiveness of the controls, simplifies correcting for turbulence and gusts, and provides a measure of protection against PIOs. The added speed also provides a safety margin above the stall speed since variations in the headwind component affect airspeed.

Caution: The pilot should not exceed the glider's tow speed limitations when adding speed for takeoff in windy conditions.

Pilot Induced Roll Oscillations During Launch

As the tow pilot applies power, the glider moves forward, balanced laterally on its main wheel by the wing runner. After the wing runner lets go and before the glider achieves significant speed, a wingtip may drop toward the ground. In response, the pilot may apply considerable control displacement leading to a series oscillations and potential wingtip ground contact. [*Figure 7-7*]

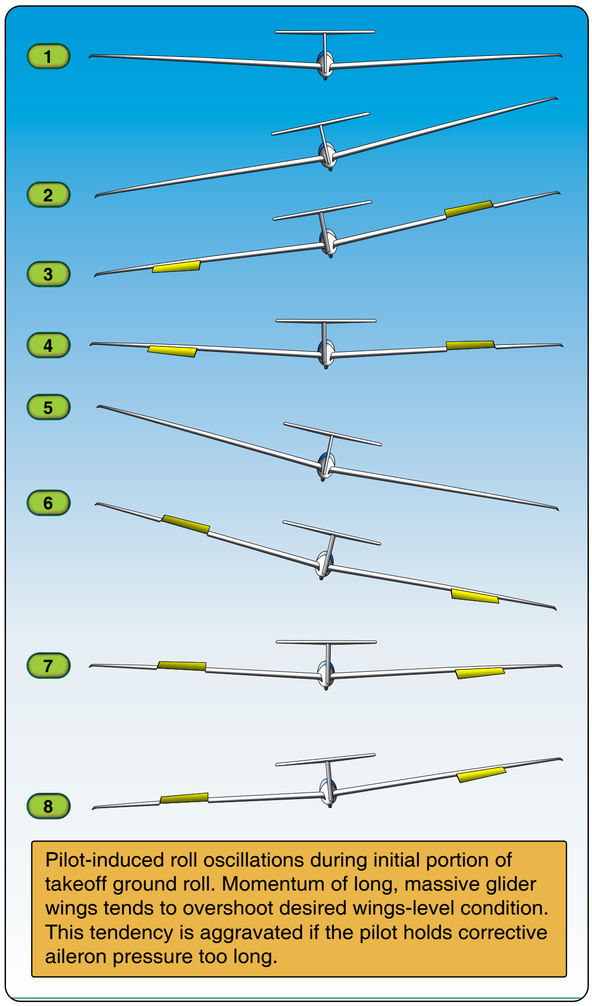

Figure 7-7. *Pilot-induced roll oscillations during takeoff roll.*

If a glider's wingtip contacts the ground during takeoff roll, the drag of the wingtip on the ground induces a yaw in the direction of the grounded wingtip. Mild drag and yaw result with a wingtip on smooth pavement, but strong drag and yaw develop from a wingtip dragging through tall grass. If appropriate aileron pressure fails to raise the wingtip off the ground quickly, the pilot should release the tow line before losing control of the glider.

Pilot Induced Yaw Oscillations During Launch

If the glider veers away from the tow plane while on the ground, rudder application in the appropriate direction corrects the situation. As the glider continues to accelerate, the effect of the rudder increases, and the lag time decreases. The pilot should anticipate the momentum of the glider about the vertical axis and reduce pressure on the rudder pedal when the nose of the glider begins to yaw in the desired direction. [*Figure 7-8*] If the pilot holds rudder pressure too long, momentum of the glider results in an overshoot of the desired yaw position. In extreme cases, and after a series of PIOs, the glider may veer off the runway or force the tow plane off the runway.

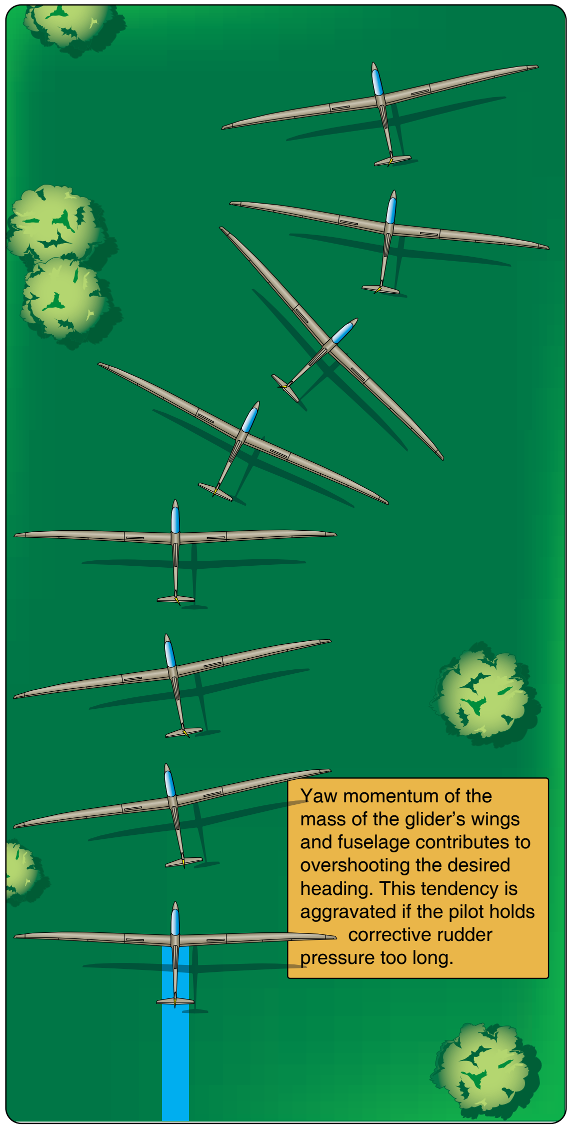

Figure 7-8. *Pilot-induced yaw oscillations during takeoff roll.*

Common Errors

Common errors in aerotow takeoffs include:

- Improper glider configuration for takeoff.
- Improper initial positioning of flight controls.
- Improper alignment of the glider (unassisted takeoff).
- Improper use or interpretation of visual launch signals.
- Failure to maintain alignment behind towplane before towplane becomes airborne.
- Improper alignment with the towplane after becoming airborne.

- Climbing too high after lift-off and causing a towplane upset.

Aerotow Climb-Out

The towplane's wake drifts down behind the towplane, and the glider can climb either above or below that wake. During high-tow, the glider pilot maintains a position slightly above the wake of the towplane. During low-tow flight, the pilot positions the glider just below the wake of the towplane. [*Figure 7-9*] Pilots should use both positions when learning coordinated towing procedures and aerotow dynamics. For gliders with retractable gear, the pilot normally leaves the undercarriage down until after release.

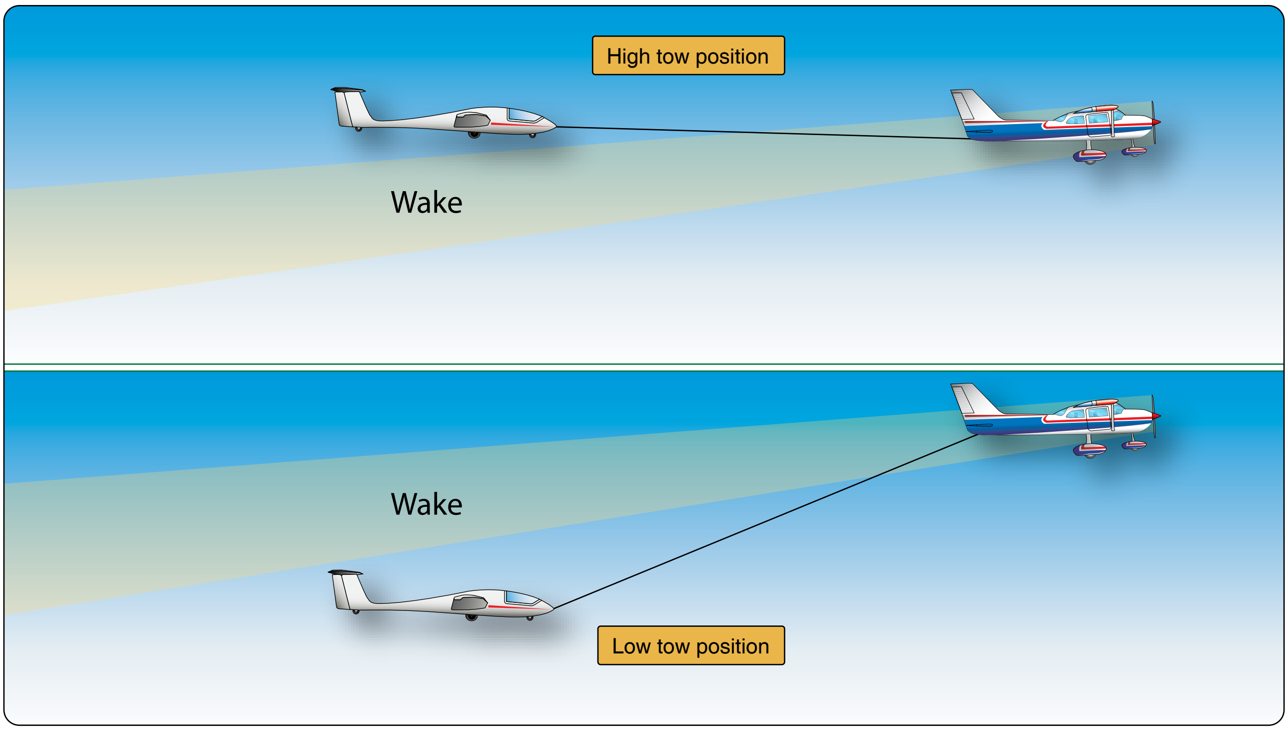

Figure 7-9. *Aerotow climb-out positions.*

The tow pilot strives to maintain a steady pitch attitude and a constant power setting for the desired climb airspeed. Any excessive deviation from the low- or high-tow position by the glider causes the tow pilot to use abnormal control inputs, which generate more drag and degrade climb performance during the tow. The glider pilot uses visual references on the towplane to maintain a proper lateral and vertical position. The glider pilot may use different sight pictures, including adjusting relative to the image of the towplane's wings on the horizon or maintaining the towplane's rudder centered over a point on the fuselage of the towplane.

Low-tow offers the glider pilot a better view of the towplane and results in a more aerodynamically efficient tow, especially during climb, as the towplane requires less upward elevator deflection due to the downward pull of the glider. However, low tow increases the risk of towline fouling from a broken towline or release by the towplane during a climb. Low tow works well for a level-flight tow during a cross-country flight.

The tow pilot normally makes climbing turns using shallow bank angles. During turns, the glider pilot observes the towplane, matches the bank angle in a coordinated turn, and aims the nose of the glider at the outside wingtip of the towplane. [*Figure 7-10*]

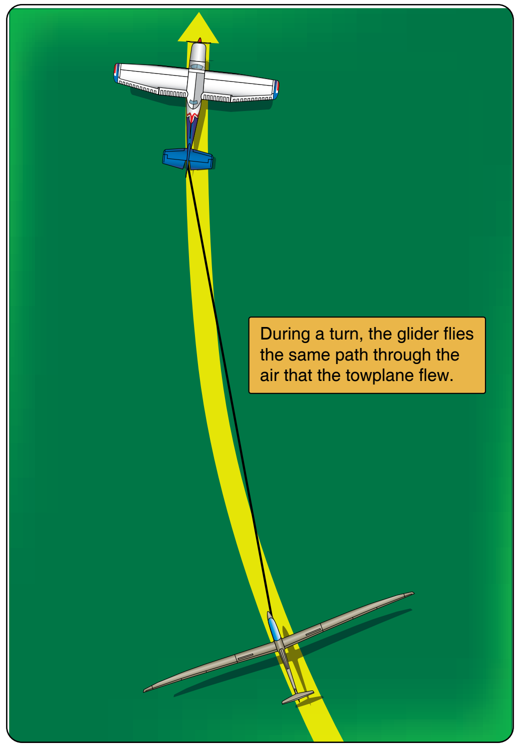

Figure 7-10. *Aerotow climbing turns.*

If the glider pilot uses a steeper bank than the towplane, the glider's turn radius becomes less than that of the towplane. [*Figure 7-11*] If this occurs, reduced tension on the tow line causes the line to bow and slack and allows the glider's airspeed to slow. As a result, the glider may begin to sink relative to the towplane. The glider pilot can correct by reducing the glider's bank angle, so the glider flies the same radius of turn as the towplane. A following section in this chapter describes how using the spoilers or performing a slip can correct for slack line.

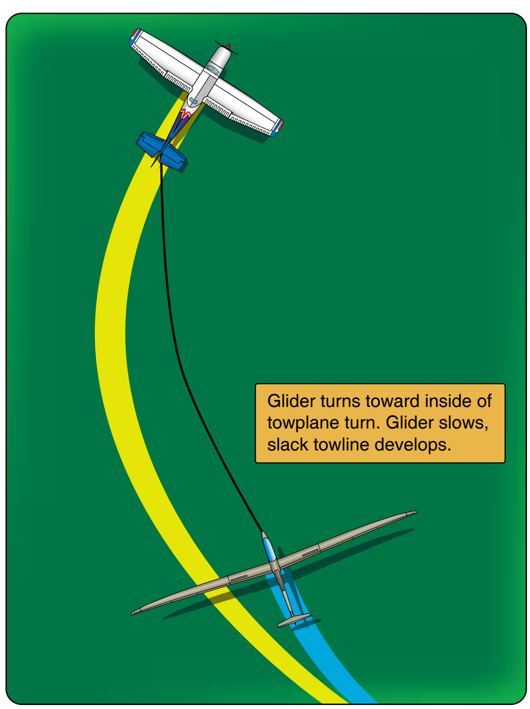

Figure 7-11. *Glider bank is steeper than that of towplane, causing slack in tow line.*

If the glider pilot uses a shallower bank than the tow plane, the glider's turn radius exceeds than that of the tow plane. [*Figure 7-12*] If this occurs, the increased tension on the tow line causes the glider to accelerate and climb. The glider pilot can correct by increasing the glider's bank angle, so the glider flies the same radius of turn as the tow plane. Without timely corrective action and if the glider climbs too high above the tow plane, the tow plane may lose rudder and elevator control. If this occurs, the glider pilot should release the tow line and turn to avoid the tow plane.

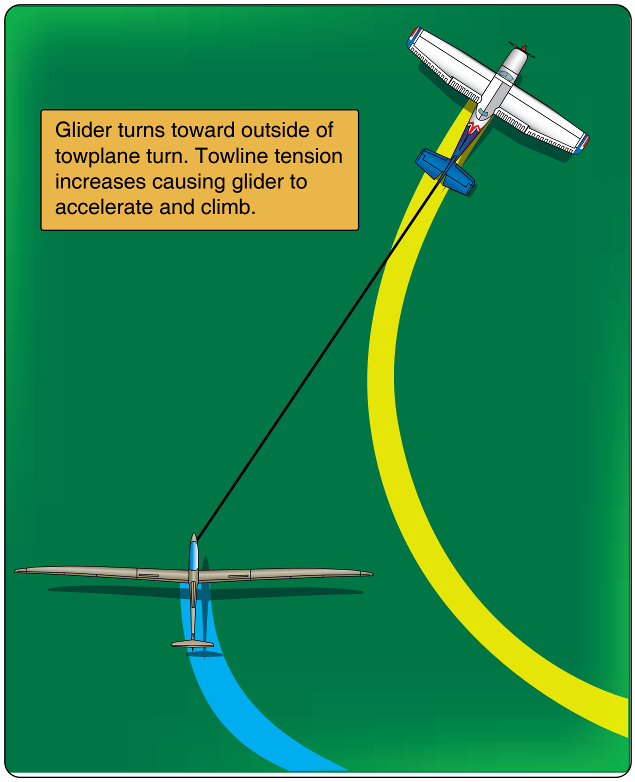

Figure 7-12. *Glider bank too shallow, causing turn outside towplane turn.*

Towline/Tow Hook Characteristics and PIOs

A short tow line keeps the glider close to the towplane and its turbulent wake and complicates glider control. Using a tow line of adequate length—200 feet minimum for normal towing operations—minimizes the influence of the towplane's wake and reduces the likelihood of PIOs.

The characteristics of the tow hook/tow line combination may cause changes in pitch attitude during the tow. On many gliders, the tow hook resides below the pilot enclosure or just forward of the landing gear. An increase in tension on the tow line causes an uncommanded pitch-up of the glider nose as shown in *Figure 7-13*. Decrease in tow line tension results in an uncommanded pitch-down. Even if rapid changes in tow line tension during a turbulent aerotow of a bellyhook-equipped glider leads to these pitch changes, the pilot should make control inputs that avoid overcontrol and PIOs.

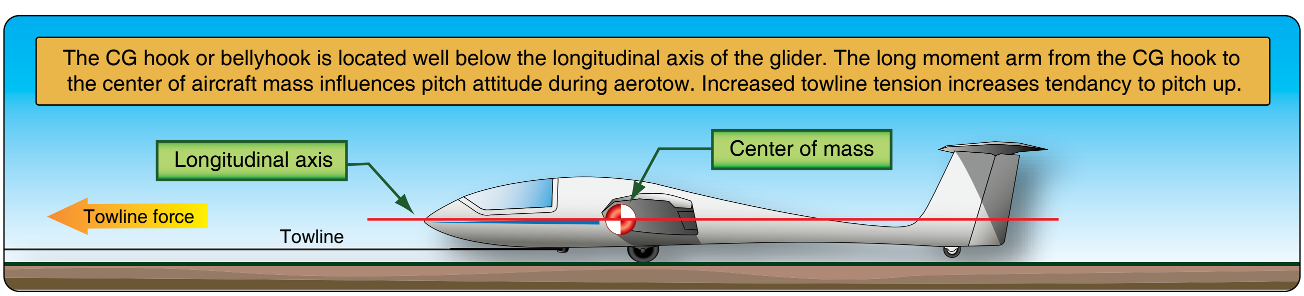

Figure 7-13. *Effects of increased tow line tension on pitch altitude of bellyhook-equipped gliders during aerotow.*

Common Errors

Common errors in aerotow climb-out include:

- Not maintaining proper vertical and lateral position during high- or low-tow.
- Inadvertent entry into towplane wake.
- Failure to maintain glider alignment during turns on aerotow.

Slack Line

Most cases of slack line are minor, require no corrective action on the part of the glider pilot, and resolve using a stabilized flight path. If severe enough, slack line or reduced tension in the tow line might entangle the glider and result in damage to the glider or towplane. Therefore, if the pilot loses sight of either the rope or the towplane, an immediate release should be accomplished.The following situations may result in a slack line:

- Abrupt power reduction by the towplane
- Aerotow descents
- Glider turns inside the towplane turn radius [Figure 7-11]
- Updrafts and downdrafts
- Abrupt recovery from a wake corner

If the towplane precedes the glider into an updraft, the glider pilot first perceives the towplane climbing faster and higher than the glider. Then, as the glider enters the updraft, it climbs more efficiently than the towplane. As a result, the glider pilot pitches the glider over to regain the proper tow position. A resulting increase in airspeed creates the slack tow line. [*Figure 7-14*] To avoid slack, the glider pilot should control the descent and closure rate to the towplane.

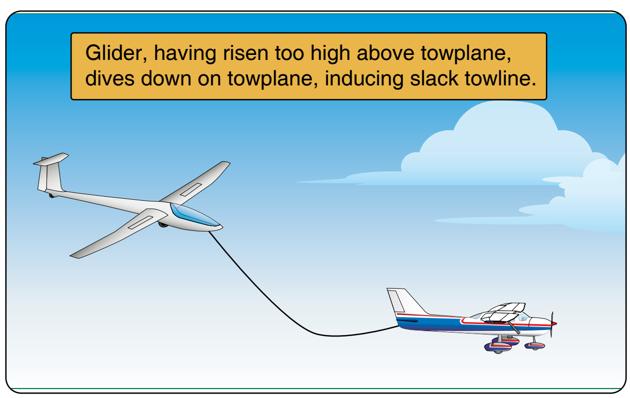

Figure 7-14. *Diving on towplane.*

The glider pilot should initiate slack line recovery procedures as soon as possible. The glider may try slipping back into alignment with the towplane. If slipping fails to reduce the slack sufficiently, careful use of spoilers or dive brakes can decelerate the glider to gently take up the slack. When the tow line tightens and the tow stabilizes, the glider pilot gradually resumes the desired aerotow position. When slack in the tow line becomes excessive or beyond the pilot's capability to safely recover, the glider pilot should release from the aerotow.

Common errors regarding a slack line recovery include:

- Failure to take corrective action at the first indication of a slack line.

- Improper procedure to correct slack line causing excessive stress on the tow line, towplane, and the glider.

Boxing the Wake

The towplane generates two types of wake turbulence. Propwash generates a light chop while wingtip vortices induce a strong rolling motion. Boxing the wake demonstrates a pilot's ability to maneuver the glider around the towplane's wake accurately and safely during aerotow. [*Figure 7-15*] A pilot can maneuver either clockwise or counterclockwise around the wake. The example below uses a clockwise example.

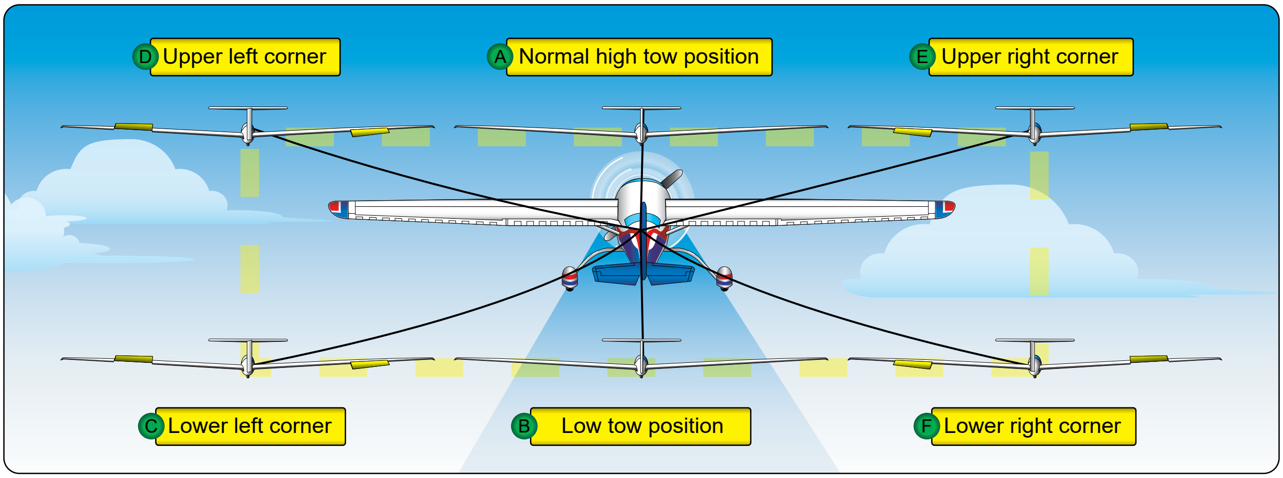

Figure 7-15. *Boxing the wake.*

Boxing the wake involves flying a rectangular pattern around the wake of the towplane. Prior to takeoff, the glider pilot should advise the tow pilot of the intention to box the wake. Boxing the wake should commence outside the traffic pattern area and no lower than 1,000 feet AGL.

Before starting the maneuver, the glider should move to the high tow position [*Figure 7-15* A] and descend from the high tow position through the wake to the center low-tow position [*Figure 7-15* B] as a signal to the tow pilot that the maneuver will begin. The pilot uses coordinated control inputs to move the glider over to the left side of the wake and holds that lower corner of the rectangle [*Figure 7-15* C] momentarily with sufficient rudder and aileron pressure.

The pilot applies sufficient control stick back pressure using the elevator to start a vertical ascent. During the ascent, the pilot uses aileron and rudder pressure to maintain constant lateral distance from the wake. The pilot holds the wings near level with the ailerons. When the glider reaches high left corner position [*Figure 7-15* D], the pilot momentarily maintains this position with sufficient rudder and aileron pressure.

As the maneuver continues, the pilot reduces the rudder pressure and uses coordinated flight control inputs to fly along the top side of the rectangle. The glider proceeds to the top right corner [*Figure 7-15* E] using aileron and rudder pressure, as appropriate. The pilot maintains this position momentarily with aileron and rudder pressure.

The pilot applies sufficient control stick forward pressure using the elevator to start a vertical descent. During the descent, the pilot uses aileron and rudder pressure to maintain constant lateral distance from the wake. The pilot holds the wings near level with the ailerons. When the glider reaches the low right corner position [*Figure 7-15* F], the pilot momentarily maintains this position with sufficient rudder and aileron pressure.

As the maneuver continues, the pilot reduces the rudder pressure and uses coordinated flight control inputs to fly along the bottom side of the box until reaching the original center low tow position [*Figure 7-15* B]. From center low tow position, the pilot maneuvers the glider through the wake to the center high tow position [*Figure 7-15* A], completing the maneuver.

Common Errors

Common errors when boxing the wake include:

- Performing an excessively large rectangle around the wake or too small a rectangle that enters the wake. Note that Figure 7-16 has exaggerated positions and is not to scale.
- Improper control coordination and procedure.
- Abrupt or rapid changes of position.
- Allowing or developing unnecessary slack during position changes.

Aerotow Release

When the aerotow reaches release position, the glider pilot should clear the entire area for other aircraft. Scanning should include to the right, which is the direction the glider will turn after release. Scanning should also include to the left, the direction the towplane turns after release. A normal release occurs with the tow line under tension since hook-type towing attachments may need that force to make the hook swing open. When ready to release, … but the glider pilot should visually confirm the tow line release prior to beginning a 90° right turn. [*Figure 7-16A*]

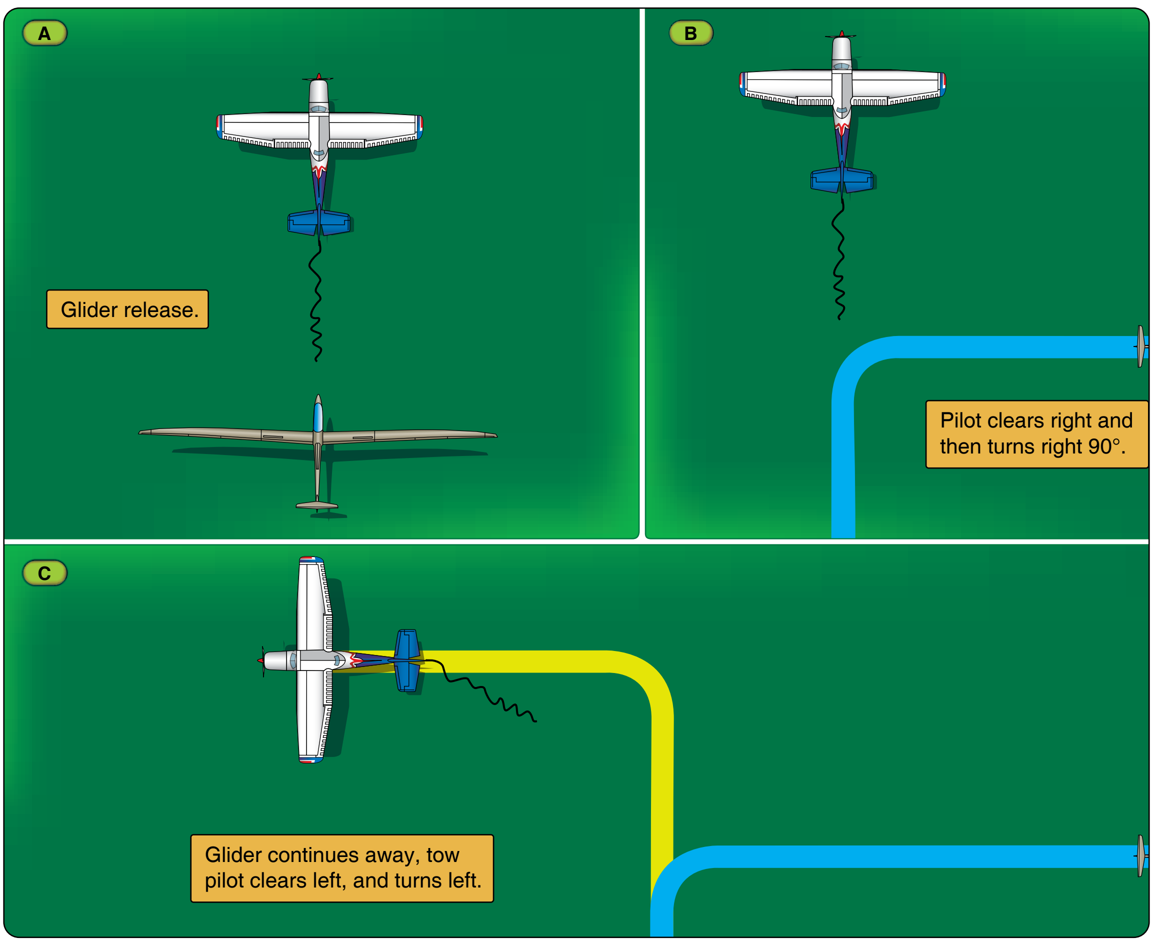

Figure 7-16. *Aerotow release.*

Figure 7-16B shows how this 90° change of heading achieves safe separation between towplane and glider in minimum time. After confirming glider release and seeing the glider turn right 90° away from the towplane, the tow pilot turns left, descending away from the release point.

Shown in *Figure 7-16C*, once clear of the glider and other aircraft, the tow pilot continues a descent toward the airport for landing. The tow pilot should continue to observe the glider as the glider pilot may start thermaling procedures and lose sight of the towing aircraft.

Common Errors

Common errors in aerotow release include:

- Lack of normal tension on tow line or slack in tow line.
- Failure to clear the area prior to release.
- Failure to visually confirm seeing the released tow line falling away prior to turning away from the towplane.
- Failure to make a 90° right turn after release.
- Release near other aircraft.
- Glider pilot or tow pilot losing sight of the other's aircraft.

Proper release procedures ensure proper aircraft separation in case the pilots lose sight of each other's aircraft. In any case, the tow pilot should exit the immediate area of the glider release. If the glider releases in a thermal or other lift, the glider normally remains in that lift to gain altitude, whereas the tow pilot can use power to return to the airport. However, both the tow pilot and glider pilot should maintain awareness of other gliders near areas of lift.

Ground Launch Takeoff Procedures

Ground launch uses a center of gravity (CG) tow hook that has an automatic back release feature. This protects the glider if the pilot cannot release the tow line during the launch. Since the failure of the tow release could cause the glider to be pulled toward the ground as it flies over the launching vehicle or winch, the pilot and ground crew should test the tow release feature prior to every flight. [*Figure 7-17*]

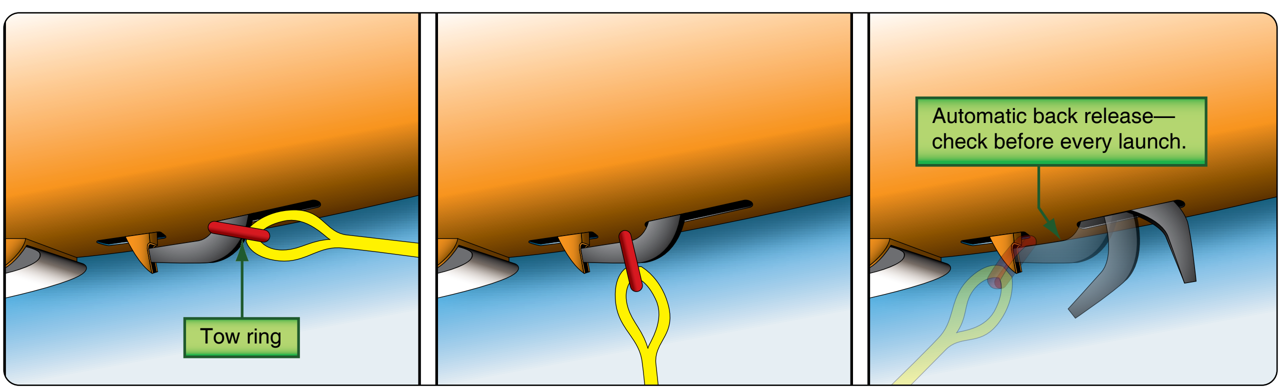

Figure 7-17. *Testing the tow hook.*

CG Hooks

Since attachment of a ground-launch tow line to a nose hook would pull the glider into the ground and overload the horizontal stabilizer and elevator, some training and high-performance gliders use a tow hook located near the CG. A CG hook gives the glider pilot control, free from any undue down moment during a ground tow. A CG hook uses a location either ahead of the landing gear, in the landing gear well, or on a bracket that attaches outside on the fuselage. If a glider only has a CG hook, and the CG hook does not have sufficient movement to fully release from an aerotow line under pressure, no aerotow should occur.

If the CG hook sits in the landing gear well, retracting the gear on tow may interfere with the tow line. For any type of tow, retracting the gear should wait until the glider achieved the desired tow altitude and releases the tow cable. Leaving the gear down also allows the glider pilot more time to assess the best landing options.

A CG hook makes a crosswind takeoff more difficult since the glider can weathervane into the wind more easily. In addition, a CG hook makes the glider more susceptible to kiting or rising too rapidly on an aerotow takeoff, especially with the CG near the aft limit.

Signals

Prelaunch Signals (Winch/Automobile)

Prelaunch visual signals for a ground launch operation allow the glider pilot, the wing runner, the safety officer, and the launch crew to communicate over considerable distances. When launching with an automobile, the glider and launch automobile may be 1,000 feet or more apart. When launching with a winch, the glider may start the launch 4,000 feet or more from the winch. Because of the distances involved, members of the ground crew use colored flags or large paddles to enhance visibility, as shown in *Figure 7-18*. When relaying information over large distances, direct voice communication between crewmember stations augments visual prelaunch signals, adds protection against premature launch, and facilitates an aborted launch if an unsafe condition arises.

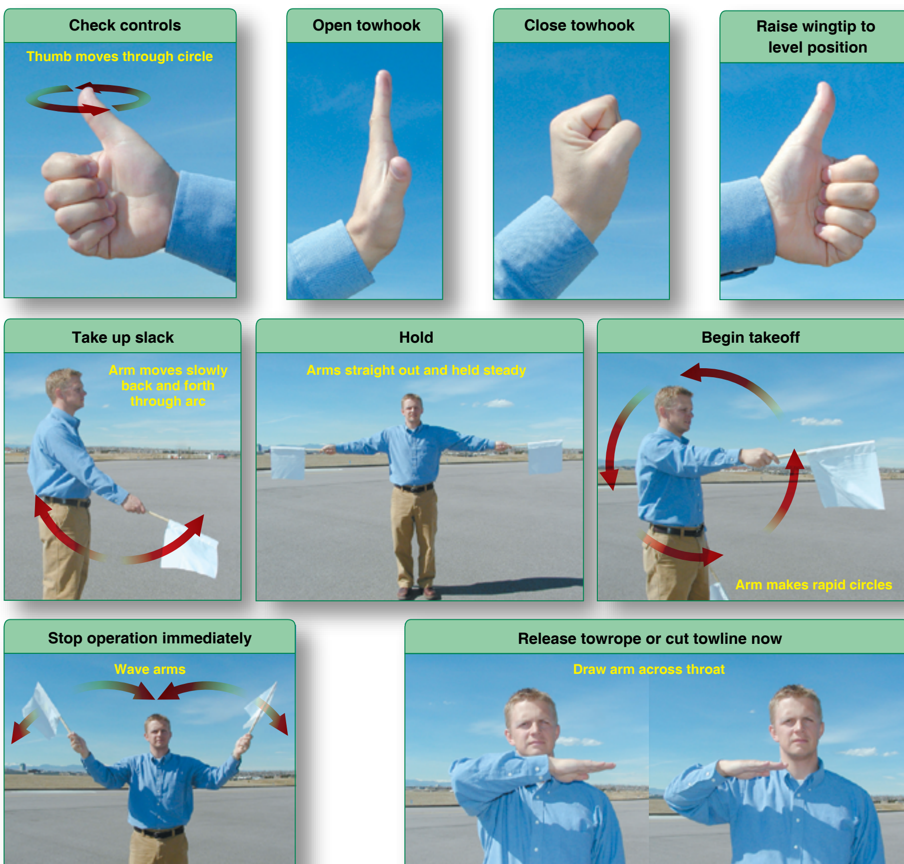

Figure 7-18. *Winch and aerotow prelaunch signals. The raise wingtip to level position is given by the pilot.*

Inflight Signals

Since ground launches occur quickly once the tow begins, inflight signals from the glider pilot to ground personnel only inform the winch operator or ground vehicle driver to increase or decrease speed. [*Figure 7-19*]

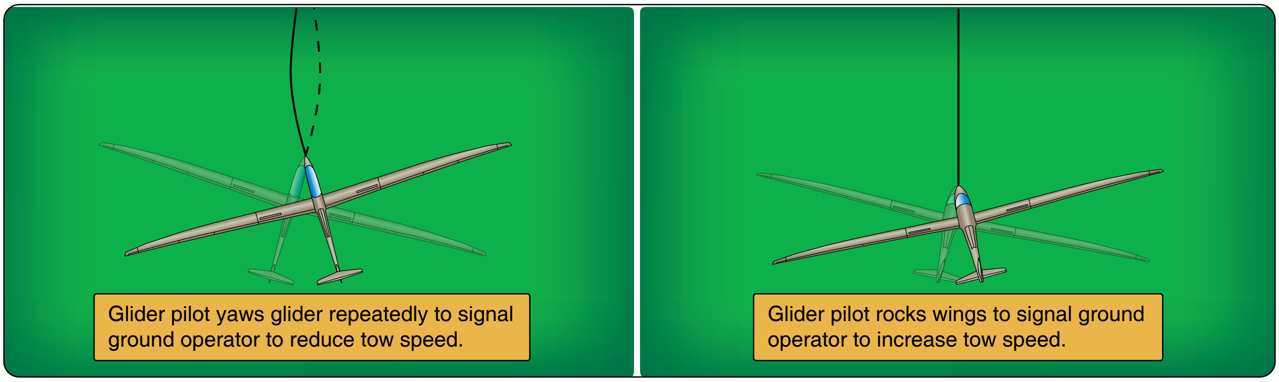

Figure 7-19. *Inflight signals for ground launch.*

Tow Speeds

The pitch attitude to airspeed relationship for a tethered glider during a ground tow presents a unique flight experience. Provided the tow mechanism has enough power to meet the energy demands of launch, a greater diversion of tow force from horizontal to vertical results in an acceleration to higher glider airspeed if the pilot pitches up. During the launch, pulling back on the stick tends to increase airspeed, and pushing forward tends to reduce airspeed.

Proper ground launch tow speeds ensure a safe launch. *Figure 7-20* compares various takeoff profiles that result when tow speeds vary above or below the correct speed.

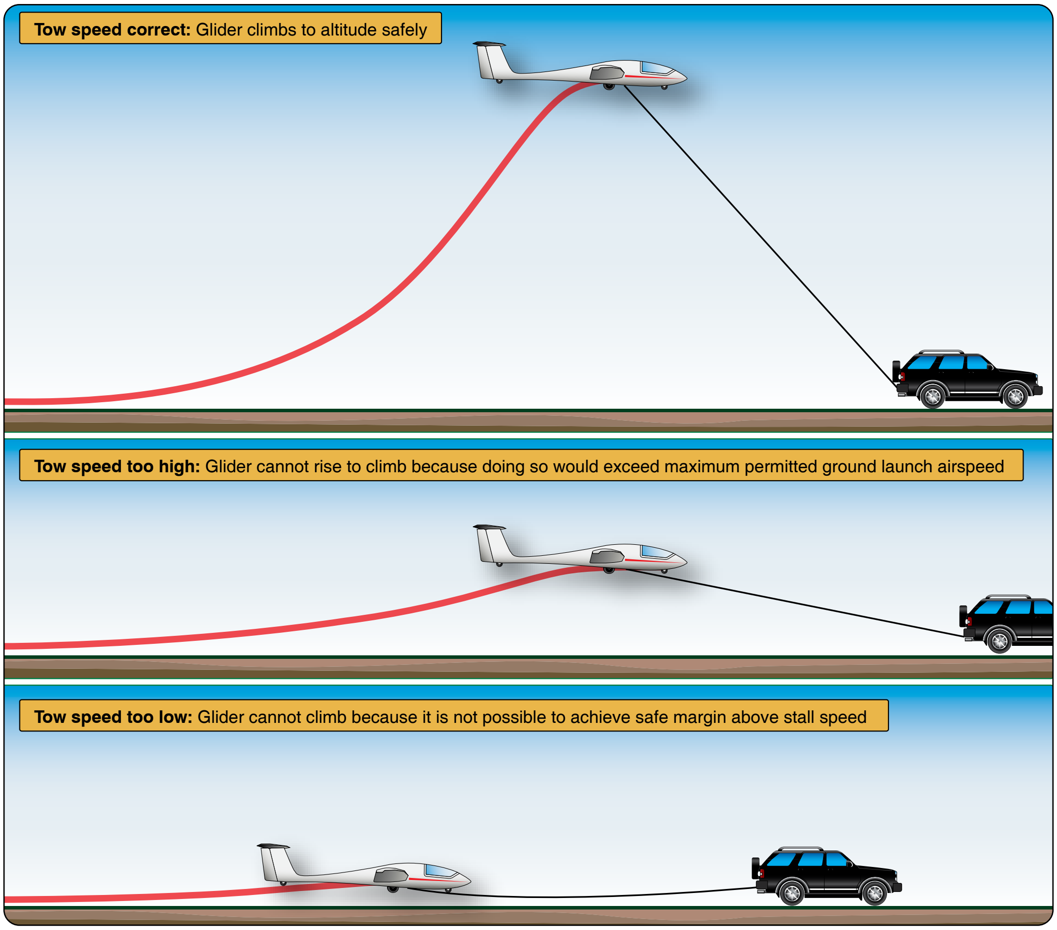

Figure 7-20. *Ground launch tow speeds.*

Each glider certified for ground launch operations has a placarded maximum ground launch tow speed. This speed usually applies to both automobile and winch launches. The glider pilot should stay at or below this speed during the ground tow to prevent structural damage to the glider.

Automobile Launch

Before the first launch, the pilot and vehicle driver should determine the appropriate vehicle ground tow speeds by considering the surface wind velocity, the expected wind gradient for the climb, and the glider speed increase during launch. The pilot and driver should agree on a maximum vehicle ground tow speed as a safety factor.

If a crosswind condition exists, the crew should position the glider slightly downwind of the takeoff heading and angled into the wind to help eliminate glider control issues during the initial portion of the tow. Due to the slow acceleration of the glider during an automobile ground launch, the tow line lay out should allow time for the glider to obtain sufficient speed while still in a headwind. [*Figure 7-21*]

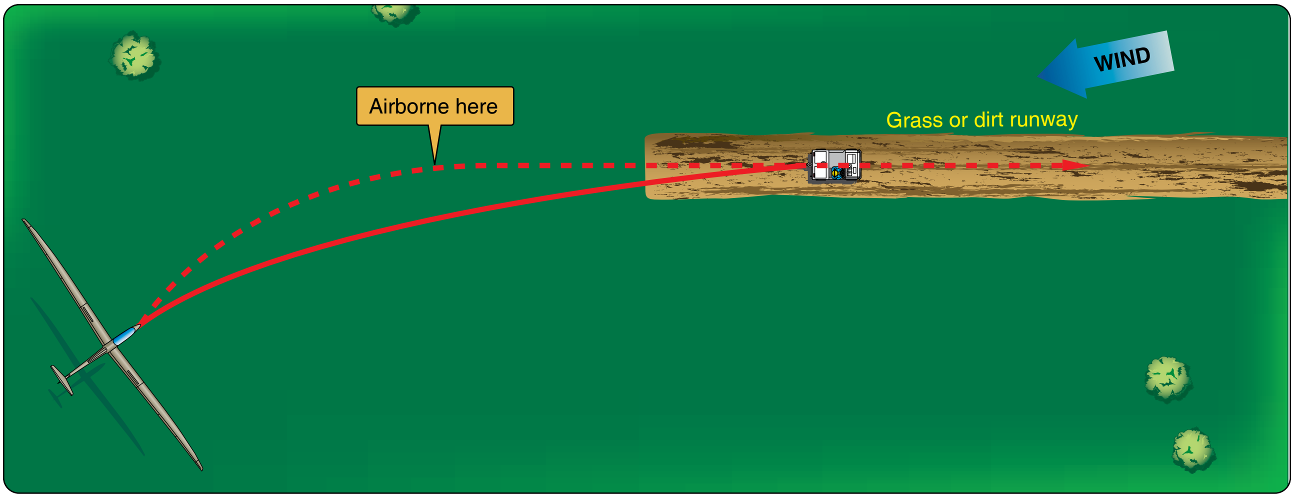

Figure 7-21. *Ground launch procedures.*

The tow speed calculation works as follows:

1. Subtract the surface winds from the maximum placarded ground launch tow speed for the glider.

2. Subtract an additional five miles per hour (mph) for the airspeed increase during the climb.

3. Subtract the estimated wind gradient increase encountered during the climb.

4. Subtract a 5 mph safety factor.

- As an example for a glider with a placarded maximum ground launch tow speed of 75 mph and with the following conditions:

  Surface winds 10 mph .... –10 mph

  Airspeed increase during climb 5 mph.......... –5 mph

  Estimated climb wind gradient 5 mph .... –5 mph

  Safety factor of 5 mph .... –5 mph

- The calculated automobile tow speed works out to………………..50 mph

Winch Launch

During winch launches, the winch operator applies full power smoothly and rapidly until the glider reaches an angle of 30° above the horizon. At this point, the operator begins to reduce the power, reaching approximately 20% power as the glider reaches a point about 60° above the horizon. As the glider reaches the 70° point above the horizon, the operator reduces power to idle. [*Figure 7-22*] The winch operator monitors the glider continuously during the climb for any signal to increase or decrease power, which would result in a change in the glider's speed.

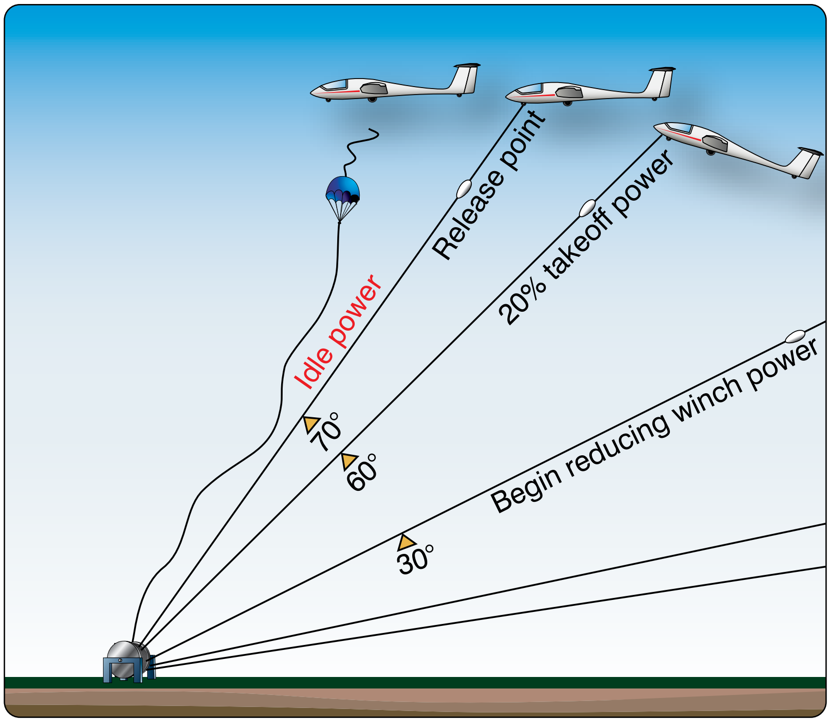

Figure 7-22. *Winch procedures.*

Crosswind Takeoff & Climb

The following are the main differences between crosswind takeoffs and climb procedures and normal takeoff and climb procedures:

- During the takeoff roll, the glider tends to weathervane into the wind.
- After liftoff, the glider drifts toward the downwind side of the runway.
- Strong crosswinds create a greater tendency for the glider to drift downwind.
- If space is available in the takeoff area, the tow line or cable should be laid out in a manner that the initial takeoff roll is slightly into the wind to reduce the crosswind component of the glider. [*Figure 7-23*]

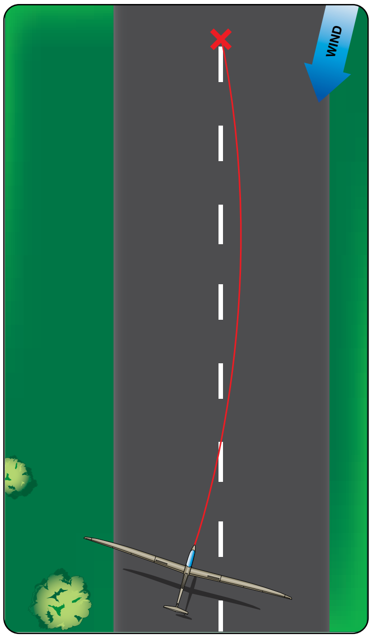

Figure 7-23. *Wind correction angle for winch procedures.*

After lift-off, the glider pilot should establish a wind correction angle and fly toward the upwind side of the runway as shown in *Figure 7-24*. After release, the tow line tends to drift back toward the centerline of the launch runway. This helps keep the tow line from fouling or damaging any wires, poles, fences, aircraft, and other obstacles off to the side of the runway.

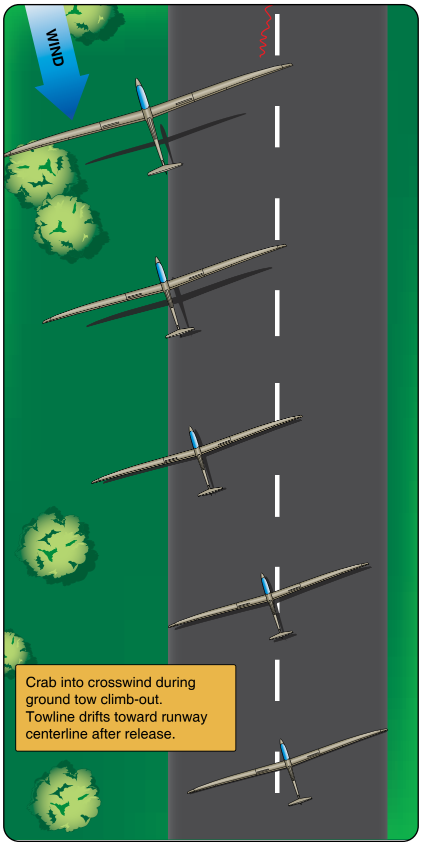

Figure 7-24. *Ground launch crosswind drift correction.*

Normal Into-the-Wind Launch

Prior to launch, the glider pilot, ground crew, and launch equipment operator brief launch signals and procedures. After completing checklists for the glider and ground launch equipment, the glider pilot should signal the ground crewmember to hook the tow line to the glider. For the release mechanism check, the ground crewmember applies tension to the tow line and signals the glider pilot to activate the release. The ground crewmember verifies that the release works properly and signals the glider pilot. After reconnecting the tow line, the ground crewmember takes a position at the wingtip of the down wing. When the glider pilot signals "ready for takeoff," the ground crewmember clears both takeoff and landing areas. After the ground crewmember ensures a clear traffic pattern, the ground crewmember then signals the launch equipment operator to "take up slack" in the tow line. With the slack removed from the tow line, the ground crewmember again verifies that the glider pilot is ready for takeoff. Then, the ground crewmember raises the wings to a level position, does a final traffic pattern check, and signals to the launch equipment operator to begin the takeoff.

The ground crewmember should never connect a glider to a tow line without the pilot onboard and ready for flight. If the pilot exits the glider for any reason, the pilot or ground crewmember should disconnect the tow line. Glider pilots should expect a takeoff anytime the tow line connects a glider to the source of the tow. If the launch begins before the pilot gives the launch signal, the glider pilot should promptly pull the tow line release handle.

The length, elasticity, and mass of the tow line used for a ground launch have several effects. First, a taut tow line often causes the glider to move forward. For this reason, the tow line should display a small amount of slack prior to beginning the launch. As the launch begins and for a few seconds, the glider pilot should hold the stick forward to avoid kiting. During the launch, the glider pilot should track the runway centerline and monitor the airspeed. [*Figure 7-25*, *position A*]

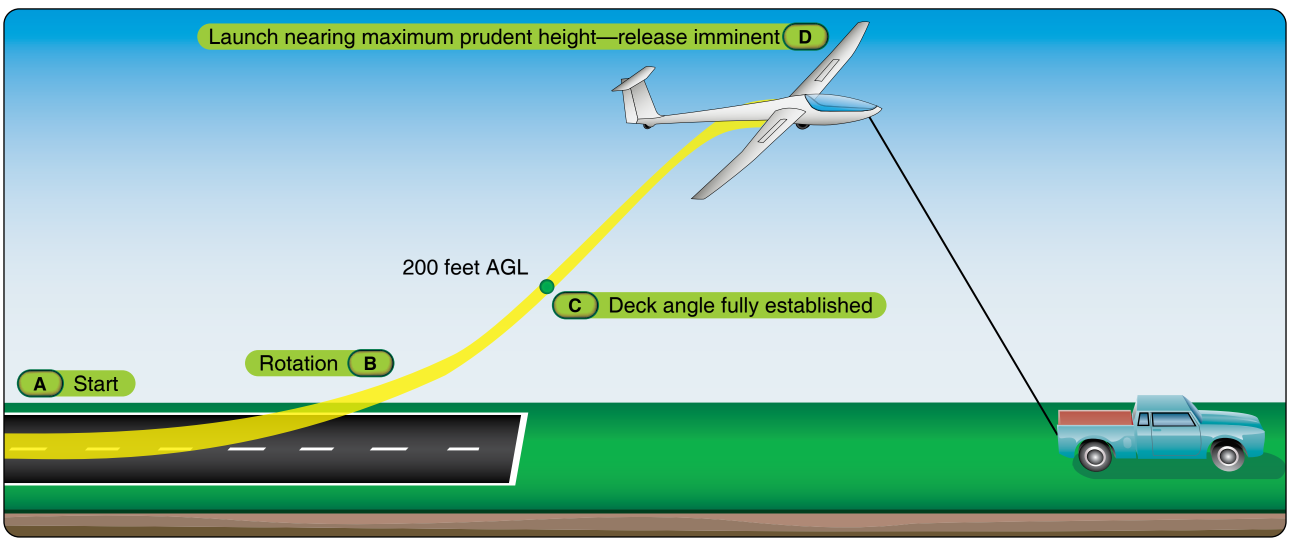

Figure 7-25. *Ground launch takeoff profile.*

When the glider accelerates and attains lift-off speed, the glider pilot eases the glider off the ground. The time interval from standing start to lift-off may be as short as 3 to 5 seconds. After the initial lift-off, the pilot should smoothly raise the nose to the proper pitch attitude, watching for an increase in airspeed. If the pilot raises the nose too soon or too steeply, the pitch attitude could become excessive while at low altitude. If the tow line breaks or the launching mechanism loses power, the pilot may find recovery from such a high pitch attitude difficult or impossible. Conversely, if the nose comes up too slowly, the glider may exceed the maximum ground launch tow speed. In addition, a shallow climb may result in the glider not reaching the planned release altitude. If this situation occurs, the pilot should pull the release and land straight ahead, avoiding any obstacles or equipment.

As the launch progresses, the pilot should ease the nose up gradually [*Figure 7-25*, position B] while monitoring the airspeed. The optimum pitch attitude for climb occurs, [*Figure 7-25*, position C] with the glider approximately 200 feet AGL. The pilot should monitor the airspeed during this phase of the climb-out to ensure an airspeed sufficient to provide a safe margin above stall speed but below the maximum ground launch airspeed. If the tow line breaks, or if the launching mechanism loses power at or above this altitude, the pilot should have sufficient altitude to release the tow line, lower the nose from the climb attitude to an approach attitude, and land straight ahead.

As the glider nears its maximum altitude [*Figure 7-25*, position D], the pilot should begin to level off above the launch winch or tow vehicle and reduce the rate of climb. In this final phase of the ground launch, the tow line pulls down on the glider. The pilot should gently lower the nose of the glider to reduce tension on the tow line and then pull the release handle two to three times to ensure tow line release. The pilot should feel the release of the tow line as it departs the glider and enter a turn to visually confirm the fall of the tow line. A broken tow line with a portion still attached to the glider may explain seeing only a portion of the tow line fall to the ground.

If pulling the release handle fails to release the tow line, the back-release mechanism of the tow hook should automatically release the tow line as the glider overtakes and passes the launch vehicle or winch.

Common Errors

Common errors in ground launching include:

- Improper glider configuration for takeoff.
- Improper initial positioning of flight controls.
- Improper use of visual launch signals.
- Improper crosswind procedure.
- Improper climb profile.
- Faulty corrective action for adjustment of airspeed and pitch.
- Exceeding maximum launch airspeed.
- Improper tow line release procedure.

Self-Launch Procedures

Preparation & Engine Start

A self-launching glider [*Figure 7-26*] has more systems than a nonmotorized glider, and manufacturers supply a more extensive preflight inspection checklist. Additional systems may include the fuel system, electrical system, engine, propeller, cooling system, and mechanisms that extend or retract the engine or propulsion system.
Whenever the engine runs, the pilot should consider the noise level and the need for hearing protection.

Figure 7-26. *Types of self-launching gliders.*

After preflighting a self-launching glider and clearing the area, the pilot starts the engine in accordance with the manufacturer's instructions. Typical items on a self-launching glider engine-start checklist include fuel mixture control, fuel tank selection, fuel pump switch, engine priming, propeller pitch setting, throttle setting, magneto or ignition switch setting, and electric starter activation. After starting and running through an after-start checklist and if the engine and propulsion systems appear within normal limits, the pilot may begin taxi operations.

Common Errors

Common errors in preparation and engine start include:

- Failure to use or improper use of checklist.
- Improper or unsafe starting procedures.
- Excessively high revolutions per minutes (rpm) after starting.
- Failure to ensure proper clearance of propeller.

Taxiing

Self-launching glider designs use different landing gear systems. Some designs use tricycle or tailwheel landing gear configurations commonly found on airplanes. Other types of self-launching gliders rest on a main landing gear wheel in the center of the fuselage and use outrigger wheels or skids on the wings to prevent the wingtips from contacting the ground.

Due to the long wingspan and low wingtip ground clearance of gliders, the self-launching glider pilot should consider airport layout and runway configuration. Some taxiways and airport ramps may not accommodate the long wingspan of the glider or limit maneuvering. Additionally, the pilot should consider the glider's crosswind capability during taxi operations. The pilot should manipulate the flight controls to prevent any crosswind from lifting a wing or causing the tail to rise. A general rule with a quartering headwind is to position the controls so as to climb into the wind while a quartering tailwind requires positioning the controls so as to dive away from the wind. Taxiing on soft ground requires additional power. Self-launching gliders with outrigger wingtip wheels may lose directional control if a wingtip wheel bogs down, and wing walkers can hold the wings level during low-speed taxi operations on soft ground.

Common Errors

Common errors in taxiing a self-launching glider include:

- Improper use of brakes.
- Failure to comply with airport markings, signals, and clearances.
- Taxiing too fast for conditions.
- Improper control positioning for wind conditions.
- Failure to consider wingspan and space required to maneuver during taxiing.

Pretakeoff Check

The manufacturer provides a before takeoff checklist. As shown in *Figure 7-27*, the complexity of many self- launching gliders makes a written takeoff checklist an essential safety item. Pretakeoff items on a self-launching glider may include checking fuel quantity and pressure, oil temperature and pressure, and other aircraft systems as applicable, conducting an engine runup, and setting throttle/rpm, propeller pitch, and cowl flaps. The pilot should also ensure seat belts and shoulder harnesses secure, doors and windows closed and locked, canopies closed and locked, air brakes closed and locked, altimeter set, communication radio set to the proper frequency for traffic advisory, and flight instruments adjusted for takeoff.

Figure 7-27. *Self-launching glider instrument panels.*

Common Errors

Common errors in the before takeoff check include:

- Improper positioning of the self-launching glider for runup.
- Failure to use or improper use of checklist.
- Improper check of flight controls.
- Failure to review takeoff emergency procedures.
- Improper radio and communications procedures.

Normal Takeoff

After completing the pretakeoff checklist, the pilot should check for traffic and prepare for takeoff. The pilot should make a final check for conflicting traffic, then taxi out onto the active runway and align the glider with the centerline. If operating from an airport with an operating control tower, the pilot must request and receive an air traffic control (ATC) clearance prior to taxi and before using any runway for takeoff.

The pilot should apply full throttle smoothly, begin the takeoff roll while tracking the centerline of the runway, fly the self-launching glider off the runway at the recommended lift-off airspeed, and allow the glider to accelerate in ground effect (IGE) until reaching the appropriate climb airspeed. If the runway has an obstacle ahead, the pilot should climb at the best angle of climb airspeed (V_X) until the obstacle is cleared. If no obstacle is present, the pilot should use either best rate of climb airspeed (V_Y) or the airspeed for best engine cooling during climb. The pilot should monitor the engine and instrument systems during climb-out. If the self-launching glider has a time limitation on full throttle operation, the pilot should adjust the throttle as necessary during the climb.

PIOs in Self-Launching Gliders

Power changes affect the glider's pitch attitude in some self-launching gliders equipped with an engine above the CG. Power changes can also cause variations in elevator effectiveness. [*Figure 7-28*] In most self-launching gliders, the effect becomes more noticeable when flying at or near minimum controllable airspeed (V_{MCA}). For this reason, self-launching glider pilots should avoid slow flight when flying at low altitude under power.

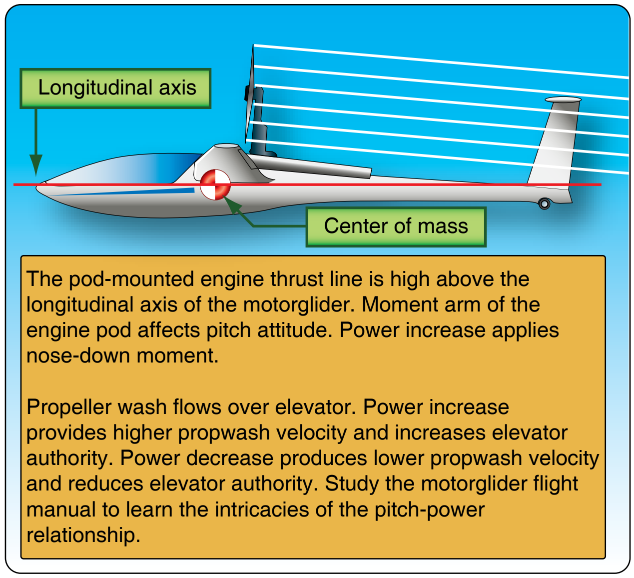

Figure 7-28. *Pitch attitude power setting relationships for self-launching glider with engine pod.*

The likelihood of PIOs around the lateral axis of self-launching gliders increases during the takeoff roll or landing with power because of power changes. The GFM/POH may contain information describing how to deal with these effects. In general, good pilot technique involves moving the throttle control smoothly, gradually, and in coordination with pitch control input.

Crosswind Takeoff

The long wingspan and low wingtip clearance of the typical self-launching glider make it vulnerable to striking a wingtip on runway signs or runway lights. In a glider with a single main wheel and no wing runner, the takeoff roll should start with the upwind wing on the ground with the aileron and rudder controls set for the current wind situation. For example, with a crosswind from the right, the right wing should be down, the control stick should be held to the right, and the rudder should be held to the left. The aileron input keeps the crosswind from lifting the upwind wing, and the downwind rudder minimizes the tendency of the self-launching glider to weathervane in a crosswind. As airspeed increases, control effectiveness improves, and the pilot can gradually decrease the crosswind control setting while maintaining the upwind wing slightly low. The self-launching glider should lift off at the appropriate lift-off airspeed and accelerate to climb airspeed. During the climb, the pilot should establish a wind correction angle and level the wings so that the self-launching glider tracks the extended centerline of the takeoff runway. [*Figure 7-29*]

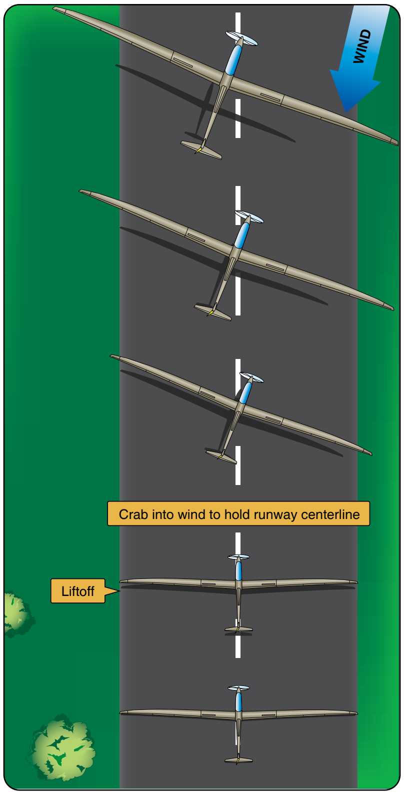

Figure 7-29. *Self-launching gliders—crosswind takeoff.*

Common Errors

Common errors in crosswind takeoff include:

- Improper initial positioning of flight controls.
- Improper power application.
- Inappropriate removal of hand from throttle.
- Poor directional control
- Improper use of flight controls.
- Improper pitch attitude during takeoff.
- Failure to establish and maintain proper climb attitude and airspeed.
- Maintaining takeoff slip instead of transitioning to crab after takeoff.

Climb-Out & Engine Shutdown Procedures

The GFM or POH provides useful information about recommended power settings and target airspeeds for best angle of climb, best rate of climb, best cooling performance climb, and cruise performance while in powered flight. Powered gliders may have additional limits that include maximum permitted airspeed with engine extended and maximum airspeed at which to extend or retract the engine. Many self-launching gliders have a time limitation on full throttle operation to prevent overheating and premature engine wear.

The engine may heat up considerably during takeoff and climb, and cooling system mismanagement can lead to dangerously high temperatures in a short time. If the self-launching glider has cowl flaps for cooling, the pilot should set the cowl flaps for high power operations. In some self-launching gliders, operating at full power with cowl flaps closed can result in overheating and damage to the engine in as little as 2 minutes. To minimize the chances of engine damage or fire, the pilot should monitor engine temperatures during high power operations and follow engine operating limitations described in the GFM/POH. If these measures do not reduce high temperatures and since extended overheating could cause an inflight fire, the safest course of action may include shutting down the engine and making a precautionary landing. An inflight fire presents a much greater threat than an emergency landing.

Handling limitations for a given self-launch may include minimum controllable airspeed with power on, minimum controllable airspeed with power off, and other limitations described in the GFM/POH. Self-launching gliders come in many configurations. Those with a top-mounted retractable engine and/or propeller have a thrust line above the longitudinal axis of the glider. Significant power changes may cause substantial pitch attitude changes. For instance, full power setting in these self-launching gliders introduces a nose-down pitching moment.

To counteract this pitching moment, the pilot normally holds the control stick back and uses trim. If the pilot quickly reduces from full power to idle power while maintaining significant control-up stick force, the glider tends to pitch up with the power reduction. This nose-pitching moment could induce a stall. Smooth and coordinated management of power and flight control provides the safest procedure under these conditions.

During climb-out, the pilot should hold a pitch attitude that results in climbing out at the desired airspeed, while adjusting elevator trim as necessary. Pilots should manage climbs in self-launching gliders using smooth control inputs and smooth and gradual throttle adjustments.

When climbing under power, most self-launching gliders exhibit a turning tendency due to P-factor. P-factor results from uneven distribution of thrust caused by the difference between the angle of attack (AOA) of the ascending propeller blade and the descending propeller blade. The pilot uses rudder to counteract P-factor during climbs with power. [*Figure 7-30*]

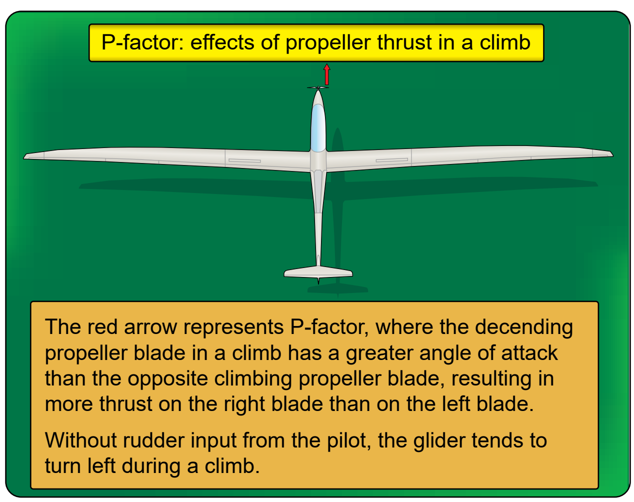

Figure 7-30. *P-factor.*

The pilot should scan for other aircraft traffic before making any turn. Coordinated aileron and rudder control, as well as turns made with a shallow bank angle, result in a more efficient flight and faster climb rate.

Detailed engine shutdown procedures are described in the GFM/POH. The manufacturer provides engine cool-down procedures for reducing engine system temperatures prior to engine shutdown. Lowering the nose to increase airspeed provides faster flow of cooling air to the engine cooling system, and several minutes of reduced throttle and increased cooling airflow may allow the engine to reach an appropriate temperature for shutdown.

When preparing to shut down the engine, the pilot should reduce power slowly to reduce or eliminate shock cooling. If shock cooling occurs, the external parts cool faster and shrink more than the interior components resulting in binding and scuffing of moving parts such as piston rings and valves while the engine continues to operate.

If the engine retracts, additional time after engine shutdown may reduce engine temperature to acceptable limits prior to retracting and stowing the engine in the fuselage. Consult the GFM/POH for details.

Retractable-engine self-launching gliders become aerodynamically more efficient after stowing the engine. The alignment of the propeller blades may need adjustment to prevent interference with the engine bay doors.

When the engine/propeller installation sits aft of the pilot's head, the gliders may have a mirror that enables the pilot to perform a visual propeller alignment check prior to stowing the engine/propeller pod. The GFM/POH contains detailed instructions for stowing the engine and propeller for a particular glider. If a malfunction occurs
during engine shutdown and stowage, the pilot may not be able to stow or extend the engine for restart. In this case, glide performance will be reduced by as much as 50%. See GFM/POH for specific information. In anticipation of this eventuality, the pilot should have a landing area within power-off gliding distance.

Some self-launching gliders use a nose-mounted engine/propeller installation that resembles a single-engine airplane. In these self-launching gliders, the shutdown procedure usually consists of operating the engine for a short time at reduced power to cool the engine to shutdown temperature. After shutdown, the pilot should close cowl flaps (if installed) to reduce drag and increase gliding efficiency. The manufacturer may recommend a time interval between engine shutdown and cowl flap closure to prevent excess temperatures buildup in the confined engine compartment. These temperatures may not be harmful to the engine itself, but may degrade structures around the engine, such as composite engine mounts or installed electrical components. Excess engine heat can also result in fuel vapor lock that prevents a subsequent restart.

Some installations have a propeller feathering system that reduces propeller drag during non-powered flight. If the pilot can control the propeller blade pitch while in flight or after shutdown, the pilot should set the propeller as described in the GFM/POH. For any inflight engine restart the pilot should follow the manufacturer's procedures.

Common Errors

Common errors during climb-out and shutdown procedures include:

- Failure to follow manufacturer's recommended procedure for engine shutdown, feathering, and stowing (if applicable).
- Failure to maintain positive aircraft control while performing engine shutdown procedures.
- Failure to follow proper engine extension and restart procedures.

Gliderport/Airport Traffic Patterns & Operations

Gliderports and airport operators within the United States should comply with Federal Aviation Administration (FAA) recommended procedures established in Advisory Circulars (AC), the Aeronautical Information Manual (AIM), and current FAA regulations. These publications serve as good references to help ensure safe glider operations.

Airport managers and glider operators usually establish traffic patterns for their operation to accommodate all the activities that take place. Pilots planning to operate at a gliderport or airport should obtain a thorough briefing or checkout before conducting flights at that facility. The landing surface serves as the primary reference to begin and fly each approach to the landing area. Pilots commonly use an initial point (IP) as shown in *Figure 7-31*, which at the recommended altitude will provide for sufficient gliding distance to reach the landing field with an adequate safety margin. The sequence of a normal approach runs from over the IP to the downwind leg, base leg, final approach, flare, touchdown, rollout, and stop. The IP may be located over the center of the gliderport/airport or at a remote location near the traffic pattern. Once past the IP, pilots normally manage their energy to compensate for wind, traffic, terrain and obstacles. While a rectangular traffic pattern is preferred, pilots may need to modify their traffic pattern since flying a pattern that results in a landing as intended takes precedence over a rectangular pattern structure.

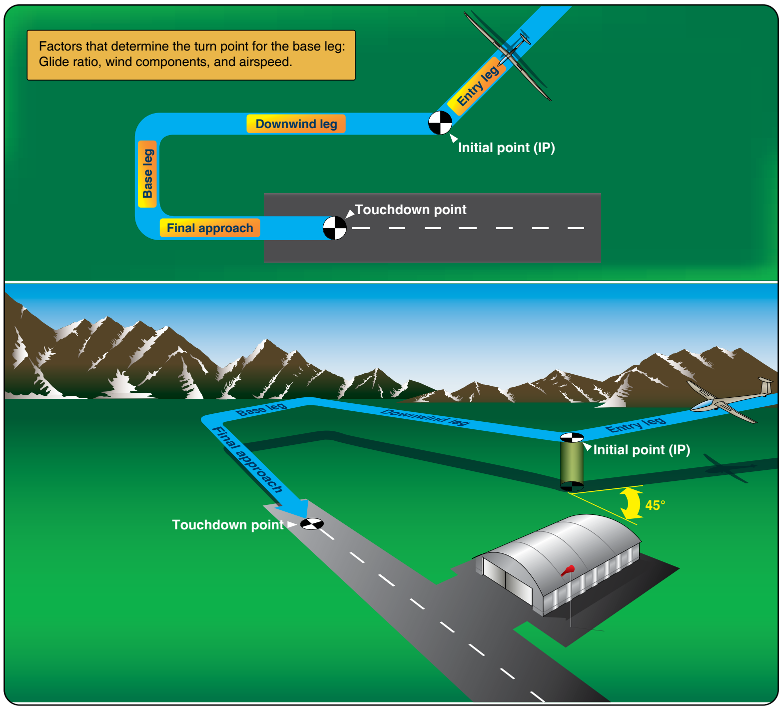

Figure 7-31. *Traffic pattern.*

Pilot should understand the rationale for determining an IP. When approaching an unfamiliar landing area, a pilot may not have a known IP. In this situation, the pilot should use the landing surface as the primary reference and set up a traffic pattern that provides an equivalent margin of safety. Pilots should develop proper placement, altitude, and distances based on wind, traffic, terrain, obstacles, and glider performance. In addition to environmental factors, the pilot should plan for an approach and landing with other participating traffic in the pattern and know the right of way rules.

While glider pilots may compensate for winds and modify the traffic pattern to retain a safe approach angle, the pilot normally plans to fly over the IP, where known, at an altitude of 800 to 1,000 feet AGL or as recommended by the local field operating procedures. Once over the IP, the pilot flies along the downwind leg of the planned landing pattern. During this time, the pilot should look for other aircraft and listen to the radio, if installed, for other aircraft in the vicinity of the gliderport/airport. Glider pilots should plan to make any radio calls early in the pattern and then concentrate on the landing task.

Pilots should complete the landing checklist prior to the downwind leg. A popular landing checklist mnemonic uses the acronym FUSTALL.

- Flaps—set (if applicable)
- Undercarriage—down and locked (if applicable)
- Speed—normal approach speed established (as recommended by the GFM/POH)
- Trim—set
- Air brakes (spoilers/dive brakes)—checked for correct operation
- Landing area—look for wind, other aircraft, and personnel
- Land the glider

Normal Approach & Landing

Planning for an approach begins at some distance from the landing zone. Prior to the IP and downwind leg entry, the pilot should consider the approach angle, distance from the landing area, spacing to accommodate other aircraft, and desired approach airspeed. Pilots normally use the recommended approach speed in the GFM/POH, but they may use 1.5 V_{SO} in the absence of a recommended approach speed. The pilot should use spoilers/dive brakes as necessary to dissipate excess altitude while maintaining the desired approach airspeed. During the entry into the traffic pattern, pilots should manage trim and make coordinated turns limited to no more than 45° of bank, and the pilot should not conduct a 360° turn once established on the downwind leg.

Downwind Leg

When approaching the IP, the pilot should maneuver the glider to enter the downwind leg. The lateral distance from a downwind leg to the landing area should be such that the glider pilot can look down to the centerline of the landing area at a 30- to 45-degree angle. This sight picture equates to a lateral distance to the landing area of 800 to 1200 feet, which allows the glider to fly inside any airplane traffic pattern and gives a better view of the landing area. The exact distance depends on winds, other weather conditions, the type of glider, and the site topography. On a typical downwind leg, the glider should descend to arrive abeam the touchdown point at an altitude between 500 and 600 feet AGL. The pilot may use the spoilers/ dive brakes to arrive at this altitude. The pilot should also monitor the glider's position with reference to the touchdown area. If the wind pushes the glider away from or toward the touchdown area, the pilot should establish a wind correction angle, stop the drift, and plan to shorten or lengthen the downwind as needed. On the downwind leg, groundspeed increases with any tailwind and shortens the elapsed time to reach the point at which to turn base.

Base Leg

The base leg normally starts with the touchdown point no more than 45° over the pilot's shoulder looking back at the touchdown area if under a no wind condition. However, pilots should adjust the downwind length based on the glide ratio of the glider flown. Each glider pilot should evaluate the landing conditions, configure the glider for landing under those conditions, and turn to base while keeping the point of intended touchdown within easy gliding range. Performing a slip or extending drag devices can dissipate excess altitude, but nothing on a non- motorized glider will make up for insufficient altitude.

Once established on the base leg, the pilot should scan for and detect any aircraft on long final approach. If using a radio, the glider pilot can broadcast position for turn to final. The pilot should adjust the turn to correct for wind drift encountered on the base leg and roll out on a heading that aligns with the landing area. The pilot should also adjust the spoilers/dive brakes and/or slip as needed to position the glider at the desired approach angle. New pilots should learn to properly scan for another aircraft operating in the traffic pattern. Pilots should also review the current revision of FAA Advisory Circular (AC) 90-48, Pilots' Role in Collision Avoidance.

Final Approach

The turn onto the final approach should not exceed a 45° bank and the pilot should use an appropriate approach angle to start the final descent. The pilot normally makes a coordinated turn from base to final to line up with the centerline of the touchdown area. The pilot should adjust the spoilers/dive brakes, as necessary, to fly the desired approach angle to a specific spot on the ground and establish a stabilized approach at the recommended approach speed.

Stablized Approach

A stabilized approach requires the pilot to judge certain visual clues and then maintain a constant final descent airspeed, approach angle, and configuration. Glider pilots should plan a downwind and base leg that allows them to turn from base to final in position to continue on a stabilized approach. The final approach with spoilers/dive brakes extended approximately half open (not necessarily half travel of the spoiler/dive brake control handle) creates an ideal approach for most gliders. The pilot can devote significant attention toward outside visual cues to fine tune the approach. The pilot should not stare at any one place, but rather scan from one point to another, such as from the aiming point to the horizon, to any objects along the landing surface, to an area well short of the landing surface, and back to the aiming point. This makes it easier to perceive any deviation from the desired glide path and determine if the glider is proceeding directly toward the aiming point. The pilot should also glance at the airspeed indicator periodically and correct for any airspeed deviation.

A glider descending on stabilized final approach travels in a straight line towards a spot on the ground ahead, commonly called the aiming point. If the glider maintains a constant glide path without a flare for landing, it will strike the ground at the aiming point.

To the pilot, the aiming point appears to be stationary. It does not appear to move under the nose of the aircraft and does not appear to move forward away from the aircraft. This feature identifies the aiming point—it does not move. However, objects in front of and beyond the aiming point do appear to move as the distance is closed, and they appear to move in opposite directions! For a constant angle glide path, the distance between the horizon and the aiming point remains constant. If descending at a constant angle and the distance between the perceived aiming point and the horizon appears to increase (aiming point moving down away from the horizon), then the true aiming point is farther down the runway. If the distance between the perceived aiming point and the horizon decreases, meaning that the aiming point is moving up toward the horizon, the true aiming point is closer than perceived.

When the glider is established on final approach, the landing surface normally appears as an elongated rectangle. When viewed from the air during the approach, the phenomenon known as perspective causes the landing surface to assume the shape of a trapezoid with the far end looking narrower than the approach end and the edge lines converging ahead. As a glider continues down the glide path at a constant angle (stabilized), the image the pilot sees keeps the same shape, but with proportionately larger dimensions. In other words, during a stabilized approach, the perceived shape of the landing surface should not change. [*Figure 7-32*]

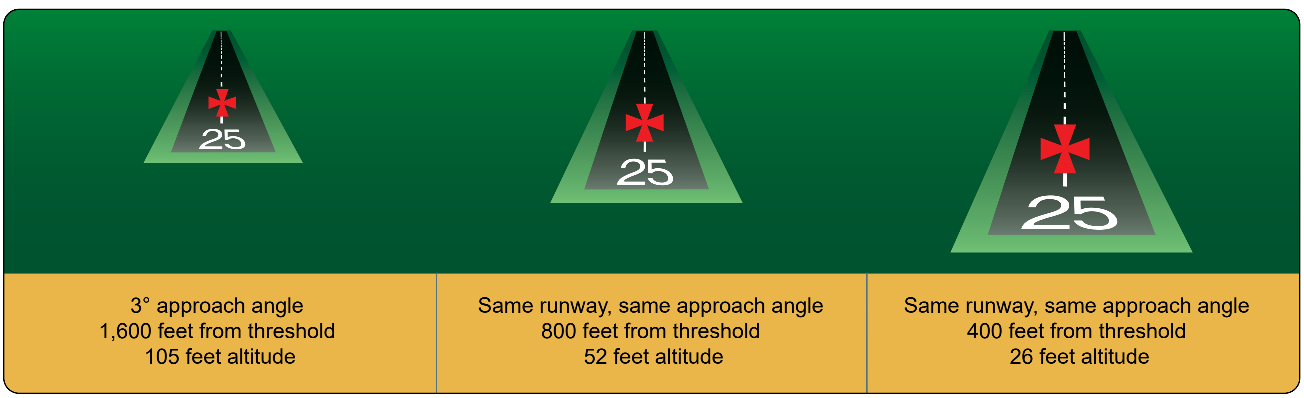

Figure 7-32. *Runway shape during stabilized approach.*

If the approach becomes shallow, the landing surface appears to shorten and becomes wider. Conversely, if the approach is steepened, the landing surface appears to become longer and narrower. [*Figure 7-33*]

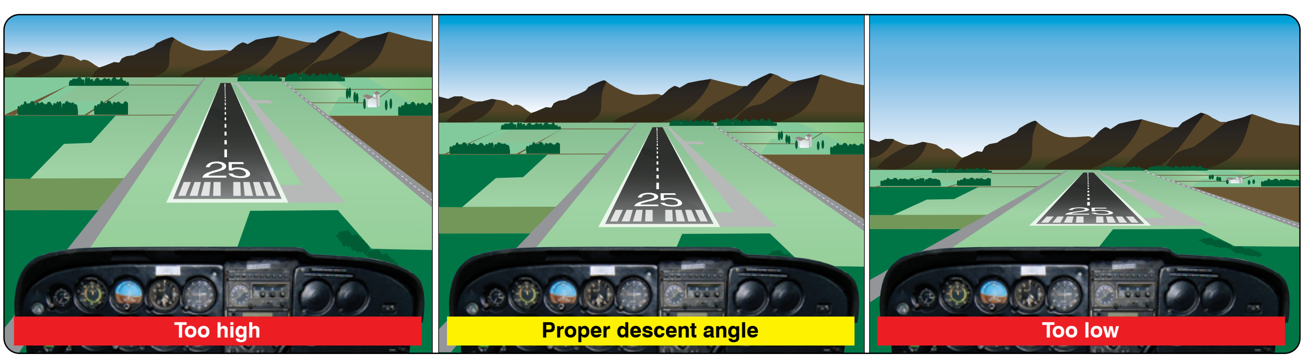

Figure 7-33. *Change in runway shape if approach becomes narrow or steep.*

During instruction and practice, a glider pilot acquires the skill to use visual cues to discern the true aiming point from any distance out on final approach. From this, the pilot determines if the current glide path will result in either an undershoot or overshoot. Note that since the pilot reduces the rate of descent during the flare, the actual touchdown occurs farther down the field. Considering float during round out, a skilled pilot can predict the point of touchdown with some accuracy.

The round out, touchdown, and landing roll are much easier to accomplish when preceded by a stabilized final approach, which reduces the chance of a landing mishap. Therefore, the pilot should detect and correct deviations from the desired glide path early so that the magnitude of corrections is small. The pilot should make appropriate and smooth adjustments in the spoilers/dive brakes to ensure proper glidepath control and should avoid pumping the spoilers/dive brakes from full open to full close. If excess speed develops from a sudden dive at the end of the approach, the glider can float a considerable distance that could preclude touching down in the desired landing area.

Round Out & Flare

When the glider approaches approximately 5 feet above the ground in a normal descent, the pilot begins a slow, smooth transition from a normal approach attitude to a landing attitude, gradually rounding out the flightpath to one that is parallel to and a few inches above the runway. The pilot gradually applies back-elevator pressure to slowly increase the pitch attitude and AOA, which increases at a rate that allows the glider to continue settling slowly as forward speed decreases. This is a continuous process until the glider touches down on the ground.

When the AOA is increased, the lift increases momentarily and gradually decreases the rate of descent and airspeed. During the round out, the airspeed is decreased to touchdown speed while the lift is controlled so the glider settles gently onto the landing surface. The round out is executed at a rate such that the proper landing attitude and the proper touchdown airspeed are attained simultaneously just as the wheels contact the landing surface.

The rate at which the pilot executes the round out depends on the glider's height above the ground, the rate of descent, and the pitch attitude. A round out started excessively high needs to be executed more slowly than one started from a lower height. When the glider appears to be descending very slowly, the increase in pitch attitude should be made at a correspondingly slow rate.

Touchdown

The touchdown is the gentle settling of the glider onto the landing surface. During the round out, the airspeed decays such that the glider touches down on the main gear. Drag devices in a glider such as spoilers or air brakes may also be used to control the touchdown point if needed. As the glider settles, proper landing attitude is attained as necessary. The touchdown should occur with the glider's longitudinal axis parallel to the direction in which the glider is moving along the runway. Failure to accomplish this imposes severe side loads on the landing gear. To avoid these side stresses, the pilot should not allow the glider to touch down while turned into the wind or drifting. After touchdown full deployment of drag devices and use of wheel brakes will increase the deceleration in the landing roll while maintaining directional control.

Pilots should avoid driving the glider into the ground using little or no flare. This type of landing puts excessive loads on the landing gear and wings. Forcing the glider onto the ground at excessive speeds may introduce pilot induced oscillations, such as porpoising. A good glider landing in most gliders with a main wheel and tailwheel (or skid) occurs on the main wheel with the tail wheel just slightly touching or the tail wheel just barely off the surface. The main wheel can withstand the shock of landings, but the tail wheel may not. Pilots should always follow the GFM/POH recommendations of the manufacturer.

After Landing Roll

The landing process should never be considered complete until the glider has been brought to a complete stop. Accidents may occur because of pilots abandoning their vigilance and failing to maintain positive control after getting the glider on the ground. Loss of directional control may lead to an aggravated, uncontrolled, tight turn on the ground, or a ground loop. The combination of centrifugal force acting on the center of gravity (CG) and ground friction of the main wheel resisting it during the ground loop may cause the glider to tip or lean enough for the outside wingtip to contact the ground. Proper directional control needs to be established early on after touchdown. The rudder serves the same purpose on the ground as it does in the air—it controls the yawing of the glider. The effectiveness of the rudder is dependent on the airflow, which depends on the speed of the glider.

The long, low wingtips of the glider are susceptible to damage from runway signage and runway lighting. When landing on a runway or landing strip, the rollout should continue straight along the centerline of the touchdown area, and the pilot should use full back stick on the elevator while keeping the glider wings level with aileron control. Pilots normally ensure that a wing does not contact the ground until the glider reaches a low speed or stops. As control authority decays during the ground roll, the pilot should apply brakes to avoid leaving the runway or landing area. However, if an obstacle becomes a concern (possible in an off-airport landing or landing out), a coordinated turn on the ground may avoid the obstacle. Turning off the runway should be done only when the pilot has the glider under control.

Landings in high, gusty winds or turbulent conditions occur using a higher approach airspeed to improve controllability, provide a safe margin above stall airspeed, and allow better penetration into the headwind on final approach. As a rule of thumb, pilots add one-half the reported gust factor (the difference between the sustained wind and reported gusts) to the normal recommended approach airspeed.

Pilot Induced Pitch Oscillations During Landing

Over controlling the elevator during the landing flare can cause the glider to balloon well above the landing surface even as airspeed decreases toward stalling speed. If the pilot pushes the stick forward after ballooning, the glider will rapidly descend toward the ground. If the pilot pulls the control stick back to arrest the descent, the glider may balloon again or experience a hard or nose-first landing depending on the airspeed. Wind gusts and turbulence increase the likelihood of this type of PIO.

To prevent PIOs during the flare after ballooning, the pilot should stabilize the glider at an altitude of 3 to 4 feet and begin the flare anew. If ballooning occurs at a low airspeed that takes the glider higher than a normal flare altitude, the pilot may reduce the extension of the spoilers/dive brakes to moderate the descent rate.

The spoilers/dive brakes provide significant drag and reduced lift when fully deployed. A sudden extension while landing results in a high sink rate and possible hard contact with the runway. This can lead to a rebound into the air and a series of PIOs. If a wind gust or sudden retraction of the spoiler/dive brakes causes the glider to balloon, the pilot should adjust the spoiler/dive brakes smoothly to reestablish an appropriate flare.

Forward Slip

A forward slip allows the pilot to steepen the approach path without increasing airspeed. While drag devices have reduced the need for forward slips, pilots should know how to use them for short/off-field landings, and approaches over obstacles.

The forward slip retains the glider's direction of motion although the nose of the glider points away from the direction of travel. For a glider in straight flight, the pilot lowers the wing on the windward side using the ailerons. Simultaneously, the pilot yaws the glider's nose by applying opposite rudder to point the glider's longitudinal axis at an angle to its original flightpath. The correct amount of bank and yaw maintains the original ground track. The pilot should also raise the nose if necessary, to prevent the airspeed from increasing.

Pilots should allow an extra margin of altitude for safety as part of an approach. If an arrival with excess altitude occurs when nearing the boundary of the selected field, the pilot can dissipate the excess altitude using a forward slip.

The use of slips has definite limitations. Some pilots may try to lose altitude by erratic slipping rather than by smoothly maneuvering, exercising good judgment, and using only a slight or moderate slip. In off-field landings, erratic or violent slipping may lead to excess speed that could result in landing long or overshooting the entire field.

Sideslip

A sideslip, as distinguished from a forward slip, occurs with the glider's longitudinal axis held parallel to the original flightpath. While keeping the nose aligned using rudder control, the pilot lowers the wing on the upwind side of the glider and adjusts the flightpath direction by varying the bank angle. [*Figure 7-34*]

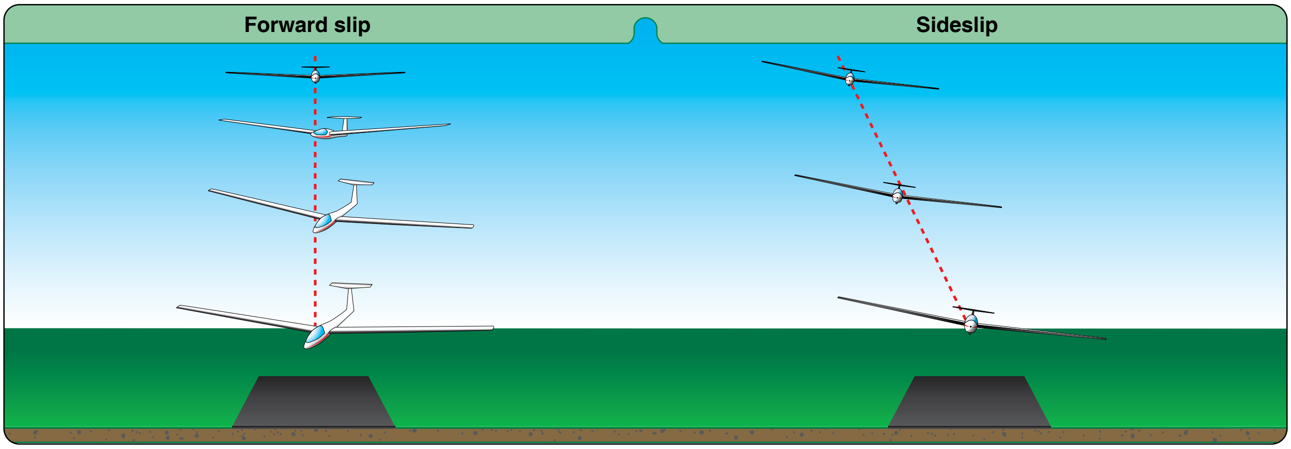

Figure 7-34. *Forward slip and sideslip.*

Common Errors

Common errors when performing a slip include:

- Improper glidepath control.
- Improper use of slips.
- Improper airspeed control.
- Improper correction for crosswind.
- Improper procedure for touchdown/landing.
- Poor directional control during/after landing.
- Improper use of spoilers, air brakes or dive brakes.

Crosswind Landing

Crosswind landings rely on a crab to correct for the effects of the wind on the final approach. A pilot performs a crab by turning the glider to a heading sufficiently into the crosswind to fly a straight track along the desired final approach path. A glider in a crab tracks the extended centerline of the landing area in coordinated flight. [*Figure 7-35A*]

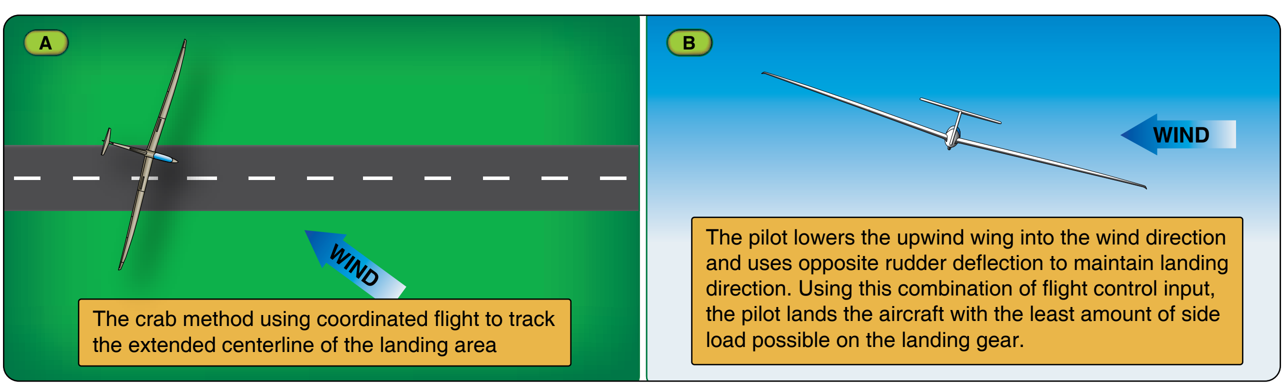

Figure 7-35. *Using the crab method to track the extended centerline of the landing area (A). Controlling side drift by adjusting the glider into the wind before landing (B).*

Pilots should transition from a crab to a sideslip on short final or prior to beginning the round out and flare. When the pilot transitions to a side slip the pilot keeps the glider aligned with the runway in uncoordinated flight using opposing rudder and aileron control. For effectiveness, the pilot aligns the nose with the runway using the rudder first. The pilot then lowers the wing on the upwind side as necessary to oppose the drift that develops from exposure to the crosswind component. [*Figure 7-35B*] Although a slip increases the sink rate of the glider, the pilot may position the spoilers/dive brakes to compensate for this additional sink rate.

Common Errors

Common errors during approach and landing include:

- Failure to complete the landing checklist in a timely manner.
- Inadequate wind drift correction on the base leg.
- An overshooting, undershooting, too steep, or too shallow a turn onto final approach.
- Poor coordination during turn from base to final approach.
- Improper glidepath control.
- Improper use of flaps, spoilers/dive brakes.
- Improper airspeed control.
- Unstabilized approach.
- Improper correction for crosswind.
- Improper procedure for touchdown/landing.
- Poor directional control during/after landing.
- Improper use of wheel brakes.

Downwind Landing

Downwind landings present special hazards and pilots should avoid this type of landing if possible. However, factors like gliderport/airport design, runway slope, or obstacles or high terrain at one end of the runway may dictate downwind takeoff and landing procedures. Emergencies or a launch failure and turn back at low altitude can also result in a downwind landing. On downwind approaches, pilots should plan a shallower approach angle and may use the spoilers/dive brakes or a forward slip, as necessary, to achieve the desired glidepath or to descend more quickly after passing over an obstacle. The pilot should use a normal approach airspeed during a downwind landing and understand that the increase in groundspeed increases the approach area and runway length needed for the landing.

The increased distance for landing due to higher speed can be determined by dividing the actual touchdown speed by the normal touchdown speed and squaring the result. For example, if the tailwind is 10 knots and the normal touchdown speed is 40 knots, the actual touchdown speed is 50 knots. (50/40)*2 = 1.56 and the landing distance increases 56 percent over the normal landing distance.

After touchdown, the pilot should use the wheel brake and all available drag devices to reduce groundspeed and stop within the available distance. Landing with a tailwind means a loss of control effectiveness at a higher groundspeed and requires more braking action.

Common errors during downwind landing include:

- Improper glidepath control.
- Improper use of slips.
- Improper airspeed control.
- Improper correction for wind.
- Improper procedure for touchdown/landing.
- Poor directional control during/after landing.
- Improper use of wheel brakes.

Landing a Self-Launching Glider

If planning a landing under power, the pilot should perform the engine restart checklist, allow sufficient time for the engine to warmup, and ensure that all systems operate properly. The pilot of a self-launching glider should have an alternate landing area available to mitigate the risk associated with decreased performance and higher drag should the engine fail to start and then fail to retract.

The pilot should fly the traffic pattern and land into the wind and with an approach angle that avoids all obstacles. The landing area dimensions should allow for touchdown and roll-out within the performance limitations of the self-launching glider. The pilot should also take into consideration any crosswind conditions and the landing surface. After touchdown, the pilot should maintain directional control, slow the self-launching glider, and clear the landing area. The pilot should complete the after-landing checklist when stopped and clear of the landing area.

Common Errors

Common errors exclusive to self-launching gliders during landing include:

- Attempting engine restart with insufficient time or altitude
- Mismanagement of engine restart.
- Not accounting for decreased glide ratio with the engine pylon extended.
- Failing to have a suitable field available in case the engine does not start.
- Landing with a side load due to parallax in powered gliders with side-by-side seating.
- Failure to use the appropriate checklist.

Nosewheel Glider Oscillations During Launches & Landings

Some gliders feature pneumatic tires on three wheels—a main wheel, tail wheel, and nose-wheel. The large main tire acts like a fulcrum and prevents both the nose tire and the tail tire from contacting the ground at the same time. With the glider in motion and if the pneumatic nose-wheel remains in contact with the ground, any bump compresses the nose-wheel tire. When the nose-wheel tire rebounds after hitting a bump at a fast ground speed, a pitch up can occur that places the tail wheel in contact with the runway, and it may compress and rebound as well.

With sufficient lift, porpoising may result if the nosewheel and tail wheel alternately hit the runway, compress, and rebound. Because this type of porpoising can damage the glider fuselage, the pilot should use elevator control to lift the nosewheel off the runway as soon as practicable during the takeoff roll so that only the glider's main wheel contacts the ground. During the landing, the pilot should hold the glider off during the flare, allow the main wheel and tail wheel touch simultaneously, and then hold the nosewheel off the ground during the rollout.

Tailwheel/Tailskid Equipped Glider Oscillations During Launches & Landings

Many gliders have a tail wheel. When loaded and ready for flight, these gliders have both the main wheel and a tail wheel/tailskid in contact with the ground, and the center of gravity location remains aft of the main wheel(s). While any upward thrust on the main landing gear tends to pitch the nose of the glider upward, the ground contact of the tail wheel or tail skid limits the change in pitch attitude.

A vigorous main wheel bump on the runway surface during the takeoff roll may push the glider into the air momentarily. At low airspeeds and with minimal elevator control, pilot over control of the elevator after an unexpected bounce or launch may result in PIOs. [*Figure 7-36*]

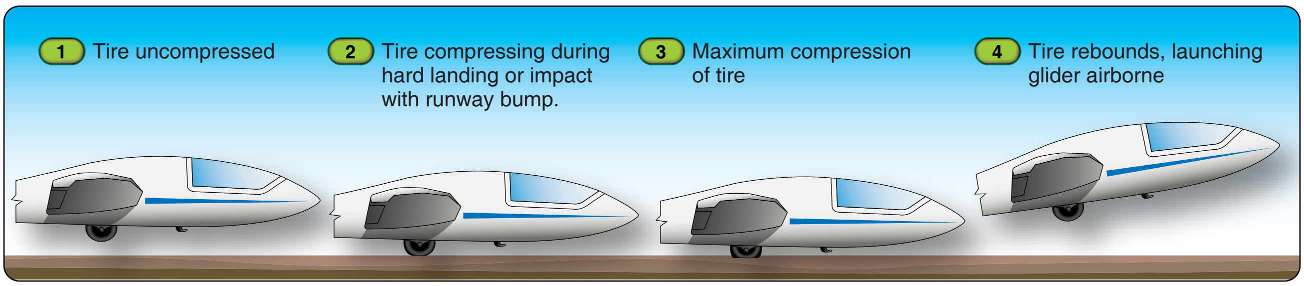

Figure 7-36. *Pneumatic tire rebound.*

During landing, main wheel contact with the ground before the tailwheel or tailskid results in compression and rebound of the pneumatic main tire, which may raise the nose of the glider, increase the angle of attack, and cause resumption of flight. Pilot overcontrol of the elevator may then lead to PIOs.

After Landing & Securing

After landing and stopping, the pilot or crew moves the glider clear of all runways. If parking the glider for a short interval between flights, an appropriate parking spot should not interfere with other gliderport/airport users or create a hazard. Pilots should close glider canopies, which are easily damaged if not secured. Because gliders can suffer wind damage, the glider should be secured if left unattended. Protecting the glider from wind may involve securing a wingtip with a weight or tie down. The manufacturer's handbook should have the recommended methods for securing the glider.

When finished with flying for the day, the pilot or crew should move the glider to the tiedown area and secure it in accordance with the recommendation in the GFM/POH. The tiedown anchors should be strong and secure. Any external control lock should be large, well-marked, and brightly painted. Pitot tube covers should use brightly colored materials for high visibility. Any canopy cover should have a soft inner surface that cannot scuff or scratch the canopy.

If storing the glider in a hangar, persons moving the glider should exercise care and maintain awareness of objects or other aircraft in the hangar. When parked in a hangar, the crew normally chocks the main wheel and tailwheel. Wing stands under each wingtip keep the glider in a wings-level position. If stored with one wing high, a weight should be placed on the lowered wing to hold it down.

If disassembling the glider for storage in a trailer, individuals tow the glider to the trailer area and normally align the fuselage with the long axis of the trailer. The pilot or crew should follow the disassembly checklist in the GFM/POH and stow the glider components securely in the trailer. Storage includes collection and stowage of all tools, closing trailer doors and hatches, and securing the trailer against wind and weather.

Performance Maneuvers

Straight Glides

The glider pilot holds a constant heading and airspeed during a straight glide and uses a prominent point on the ground in front of the glider as a heading reference. During a straight glide, each wingtip should appear at an equal distance relative to the horizon. Straight glides should be coordinated as indicated by a centered yaw string or slip-skid ball. With the wings level, the pilot establishes a pitch attitude relative to a distant point on or below the forward horizon. The pilot can hold a constant pitch attitude and a constant airspeed with little to no control pressure using the elevator trim control.

The glider pilot should listen for airflow noise changes. Any changes in airspeed or coordination cause a change in the wind noise. While gusts cause the sound and airspeed to change momentarily, the pilot can ignore the sound of gusts and hold the glider at a constant pitch attitude to maintain airspeed control.

The glider pilot should learn to fly through a wide range of airspeeds, from minimum controllable airspeed to maximum allowable airspeed. Glider pilots should also note the difference in control pressure with airspeed changes. This provides the pilot with a complete understanding of the feel of the controls of the glider. If the glider equipment includes spoilers/dive brakes and/or flaps, the glider pilot should become familiar with the changes that occur in pitch attitude and airspeed when using these controls.

Common Errors

Common errors during straight glides include:

- Rough or erratic pitch attitude and airspeed control.
- Rough, uncoordinated, or inappropriate control applications.
- Failure to use trim or improper use of trim.
- Improper use of controls when using spoilers, dive brakes, and/or flaps.
- Prolonged uncoordinated flight—yaw or ball not centered.

Turns

Turning involves all three flight controls: ailerons, rudder, and elevator. For purposes of this discussion, turns divide into the following three classes as shown in *Figure 7-37*.

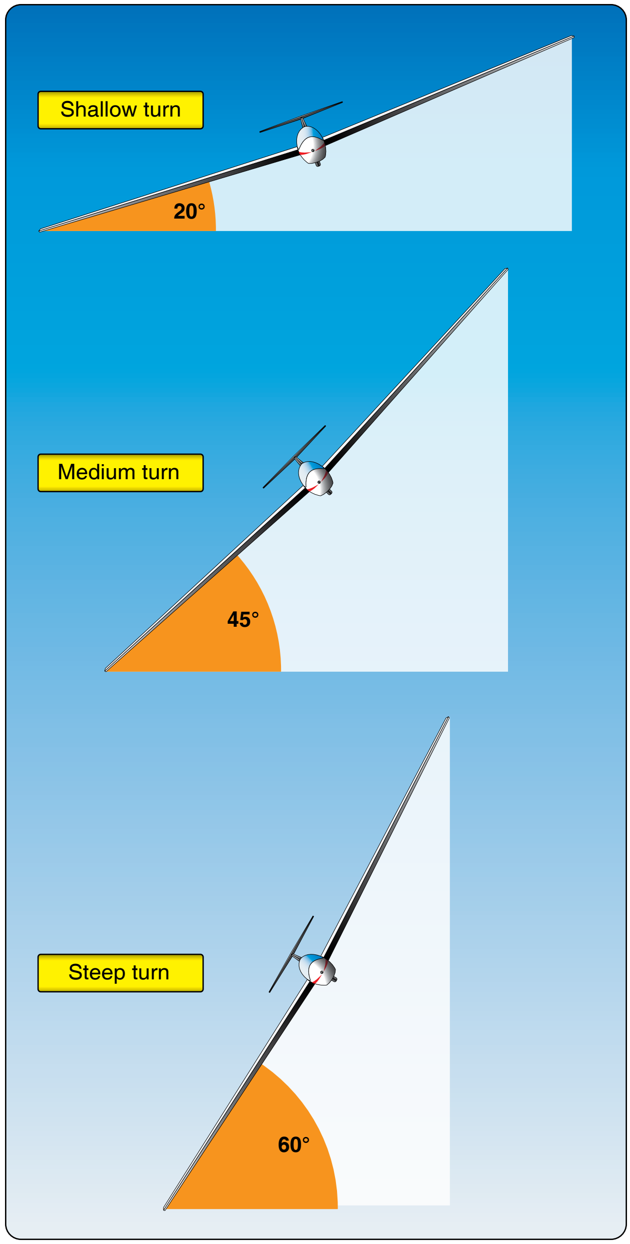

Figure 7-37. *Shallow, medium, and steep turns.*

- Shallow turns (less than approximately 20° of bank) include those in which the inherent lateral stability of the glider levels the wings unless the pilot maintains some aileron pressure to maintain the bank.

- Medium turns result from approximately 20° to 45° of bank. Lateral stability results in little to no aileron control pressure to maintain the bank angle.

- Steep turns result from a degree of bank 45° or more. During a steep turn, the overbanking tendency of a glider overcomes lateral stability, and the bank increases without opposing aileron application.

Most training gliders have a yaw string, typically a piece of yarn taped to the canopy. Pilots refer to the taped end as the head and the free end as the tail. During flight, comparing the head and tail of a yaw string identifies coordinated flight, slips, and skids. During coordinated flight, the yaw string flows straight back on the windscreen (perpendicular to the longitudinal axis) [*Figure 7-38*]. During a slipping turn, the head of the yaw string is to the inside of the turn when compared to the tail. [*Figure 7-39*] During a skidding turn, the head of the yaw string is to the outside of the turn when compared to the tail. [*Figure 7-40*].

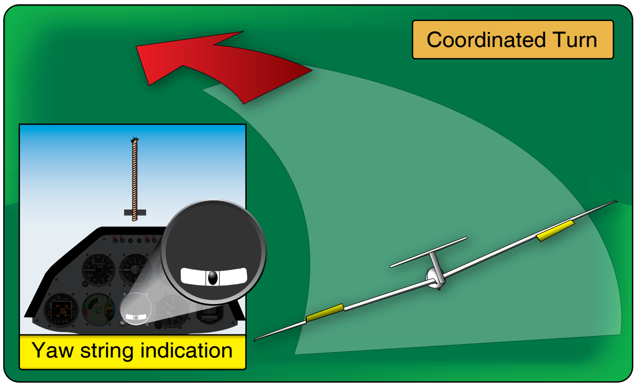

Figure 7-38. *Coordinated turn.*

Turn Coordination

In a slipping turn the glider turns at a lower rate for the bank used due to yaw toward the outside of the turning flightpath. The pilot reestablishes a coordinated turn by decreasing the bank (ailerons), increasing yaw in the direction of the turn (rudder), or a combination of the two. [*Figure 7-39*]

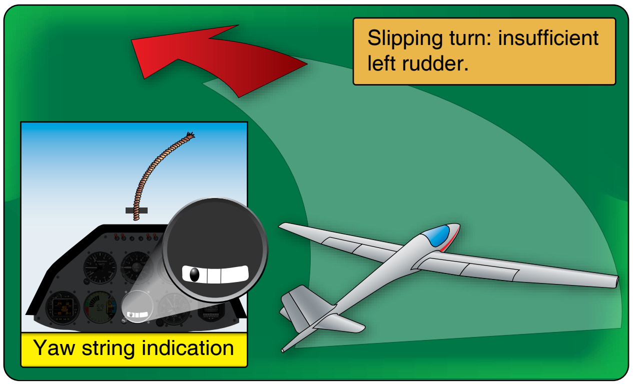

Figure 7-39. *Slipping turn.*

In a skidding turn the glider turns at a higher rate for the bank used due to the yaw toward the inside of the turning flightpath. Correction of a skidding turn involves a decrease in yaw (rudder), an increase in bank (aileron), or a combination of the two. [*Figure 7-40*]

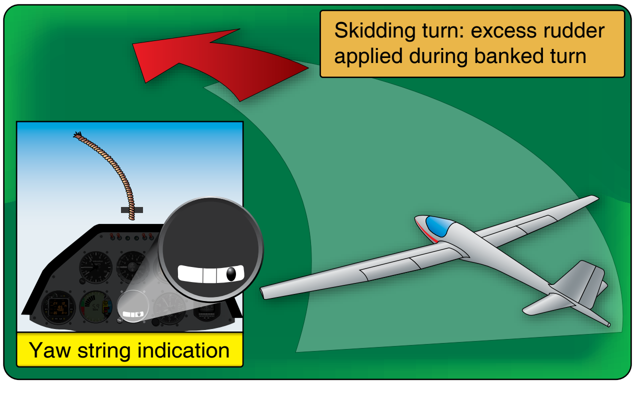

Figure 7-40. *Skidding turn.*

The ball in the slip/skid indicator also indicates coordinated flight, slips, and skids in a similar manner as the head of the yaw string. When using this instrument for coordination, the pilot can apply rudder pressure on the same side as the ball (step on the ball). The pilot's body pressure against the sides, bottom, and back of the seat respond in the same way as the ball, and many pilots can sense the force that pushes to one side or the other rather than straight down into the seat. Pilots can correct for uncoordinated condition by using appropriate rudder and aileron control pressures simultaneously or individually to coordinate the glider.

Roll-In

Before starting any turn, the pilot should clear the airspace in the direction of the turn. When applying aileron to bank the glider, the down aileron deflection on the rising wing generates greater drag while the raised aileron on the lowering wing generates less drag. This difference in drag causes the glider to yaw toward the rising wing or away from the intended direction of turn. When applying pressure to the ailerons to begin a turn and to counteract this adverse yaw, the pilot should also apply rudder pressure in the direction of turn. If using excess rudder pressure, the nose appears to yaw before the pilot establishes the bank. If using insufficient rudder pressure, the nose initially moves in the wrong direction as the pilot begins the turn. If using the correct amount of rudder pressure, the nose starts to move along the horizon, increasing its rate of travel proportionately as the bank increases.

After establishing a medium banked turn, the pilot may relax pressure applied to the aileron control. The glider tends to remain at the selected bank with no further tendency to yaw without aileron deflection. As a result, the pilot may also relax pressure applied to the rudder pedals, and the rudder streamlines itself with the direction of the slipstream. If the pilot maintains constant rudder pressure after establishing the turn, the glider skids to the outside of the turn. If the pilot makes a conscious effort to center the rudder rather than let it streamline itself to the turn, the pilot may inadvertently apply some opposite rudder pressure. This forces the glider to slip to the inside of the turn. The yaw string or ball in the slip/skid moves as described above.

As the angle of bank increases from a shallow bank to a medium bank, the airspeed of the wing on the outside of the turn increases in relation to the inside wing. The additional lift developed on the outside wing balances the lateral stability of the glider. Therefore, the pilot does not use aileron pressure to maintain a medium bank. If the bank increases from a medium to steep, the radius of turn decreases even further. The greater lift of the outside wing will cause the bank to steepen, and the pilot should use opposite aileron to hold the bank constant. Because the outboard wing develops more lift, it also has more induced drag. This causes a slid during steep turns that the pilot corrects with rudder pressure.

To establish the desired angle of bank, the pilot should use visual reference points on the glider, the earth's surface, and the natural horizon. The beginning pilot may lean away from or into the turn but should remain aligned with the seat. Any deviation prevents proper use of visual references. Large application of aileron pressure may produce rapid roll rates and allow little time for corrections before reaching the desired bank. Slower (small control displacement) roll rates provide more time to make necessary pitch and bank corrections.

While establishing the desired angle of bank and during the turn, the pilot should use elevator pressure to maintain the desired airspeed. Throughout the turn, the pilot should cross-check the airspeed indicator to verify the proper pitch. The cross-check and instrument scan should include outside visual references. If the glider gains or loses airspeed, the pilot should adjust the pitch attitude in relation to the horizon. During all turns, the pilot uses aileron, rudder, and elevator control to correct minor variations in pitch and bank.

Roll-Out

The roll-out from a turn involves application of coordinated flight controls in the opposite direction. Aileron and rudder application occur in the direction of the roll-out or toward the high wing. As the angle of bank decreases, the pilot uses elevator pressure, as necessary, to maintain airspeed.

Since the glider continues turning while in a bank, the roll-out should begin before reaching the desired heading. The amount of lead to roll-out on the desired heading depends on the degree of bank used in the turn. Normally, pilots use one-half the bank angle. For example, if the bank is 30°, the pilot leads the roll-out by 15°. As the wings become level, the pilot can smoothly relax control pressures, so the controls neutralize as the glider returns to straight flight. As the roll-out occurs, outside visual references provide indications that the wings have leveled, and the turn stopped.

Common errors during a turn include:

- Failure to clear turn.
- Nose movement before the bank starts—rudder is being applied too soon.
- Significant bank before the nose moves, or nose movement in the opposite direction—the rudder is being applied too late.
- Up or down nose movement when entering a bank—excessive or insufficient elevator is being applied.
- Rough or abrupt use of controls during the roll-in and roll-out.
- Failure to establish and maintain the desired angle of bank.
- Overshooting/undershooting the desired heading.

Steep Turns

In thermaling flight, small-radius turns can keep the glider in or near the core of a thermal updraft. To keep the radius of turn small, the pilot can establish a steep bank while maintaining an appropriate airspeed, such as minimum sink or best glide speed. The pilot should also understand that as the bank angle increases, the stall speed increases.

A steep turn results in a rapid heading change, and the pilot should clear the area for other traffic. While banked steeply, the rudder may act like an elevator. A little top rudder helps keep the nose-up attitude. If the pilot does not add sufficient back pressure or top rudder to maintain the desired airspeed as the bank angle steepens, the glider may enter a spiral dive. In summary, during a coordinated steep turn, the pilot uses back pressure on the elevator for airspeed control, aileron pressure against the raised wing for bank control, and top rudder pressure to maintain pitch attitude.

Common Errors

Common errors during steep turns include:

- Failure to clear turn.
- Uncoordinated use of controls.
- Loss of orientation.
- Failure to maintain airspeed within tolerance.
- Inappropriate division of attention inside and outside the glider.
- Unintentional stall, spin, or spiral dive.
- Excessive deviation from desired heading during roll-out.

Slow Flight

Maneuvering during slow flight demonstrates the flight characteristics and degree of controllability of a glider at reduced speeds. Pilots should develop awareness of the flight characteristics of any glider they fly to recognize and avoid stalls that may inadvertently occur during low airspeed flight used in takeoffs, climbs, thermaling, and approaches to landing.

Maneuvering during slow flight develops the pilot's sense of feel and ability to use the controls, and to improve proficiency. Pilots should use outside visual references to maintain the desired pitch attitude as well as periodically scan the airspeed indicator.

The maneuver starts from either best glide speed or minimum sink speed at a safe altitude. The pilot smoothly and gradually increases pitch attitude. While the glider airspeed decreases, the position of the nose in relation to the horizon will rise as the angle of attack increases. Since lift diminishes with the square of airspeed, the increase in angle of attack to keep lift constant becomes more pronounced as airspeed decays. As speed continues to decrease and approach the airspeed at which any further increase in angle of attack or load factor would result in a stall, the glider reaches the edge of its flight envelope at a minimum controllable airspeed. In smooth air and with no turning, minimum controllable airspeed is lower than in rough air. If in turbulence, the pilot should fly with a sufficient speed margin above the minimum controllable airspeed to avoid a stall. During slow flight or during flight at minimum controllable airspeed, the pilot should continually use the horizon to maintain desired pitch attitude and glance at the airspeed indicator to maintain the target airspeed. Trimming the glider, as necessary, compensates for changes in control pressure. The diminished effectiveness of the flight controls during slow unaccelerated flight should familiarize the pilot with the characteristics and feel of flight near the 1G stalling speed.

After establishing a slow airspeed in straight flight, turns further demonstrate the glider's characteristics at that selected airspeed. During turns, the pilot should decrease pitch attitude as needed to maintain airspeed. Otherwise, as bank steepens, the increase in load factor may result in a stall. A stall may also occur in a turn because of abrupt or rough control movements or turbulence, which increase load factor. Abruptly raising the flaps during minimum controllable airspeed flight also results in sudden loss of lift and may cause a stall. The actual speed at which a stall occurs also depends upon conditions such as the gross weight and CG location.

Pilots should also practice slow flight with the glider in different configurations such as with spoilers/dive brakes, flaps, and landing gear extended and retracted. This provides additional understanding of the changes in pitch attitude caused by the increase in drag in different configurations.

Common Errors

Common errors during slow flight maneuvers include:

- Failure to clear the area.
- Failure to establish or to maintain desired airspeed.
- Improper use of trim.
- Rough or uncoordinated use of controls.
- Excessive deviation from desired heading during roll-out.
- Failure to recognize indications of a stall.

Stall Recognition & Recovery

A stall can occur at any airspeed or attitude. In a powered glider, a stall can also occur at any power setting. Intentional stalls familiarize the pilot with the conditions that produce stalls, assist in recognizing an approaching stall, and develop the skills necessary to prevent or recover from a stall. The pilot should learn the stall characteristics and recovery procedures of the glider being flown.

Stall accidents usually result from an inadvertent stall at a low altitude in which a recovery was not accomplished prior to contact with the surface. The longer it takes to recognize the approaching stall, the more complete the stall becomes, and the greater the expected altitude loss. To mitigate the risk involving loss of altitude during recovery, pilots should practice stalls at an altitude that allows recovery within gliding distance of a landing area and no lower than 1,500 feet AGL.

Many gliders do not have an electrical or mechanical stall warning device. Pilots should recognize an approaching stall by sight, sound, and feel. The following cues should warn the pilot of an approaching stall.

1. Vision—visualizing the relative wind and angle of attack. Yaw string (if equipped) movement from normal flight position.

2. Hearing—a change in sound due to loss of airspeed.

3. Feeling—As a stall begins, the pilot starts to feel airframe buffeting or aerodynamic vibration.

   A. Kinesthesia, or the sensing of changes in direction or speed of motion, if properly developed, warns of a decrease in speed or the beginning of a settling, or mushing, of the glider.

   B. As speed decreases, the resistance to pressure on the controls becomes progressively less. The ailerons, elevator, and rudder have significantly less authority and require more movement to control the glider. Under low-speed stalling conditions, the lag between control movements and the response of the glider becomes more pronounced.

Pilots should always make clearing turns before performing stalls. During the practice of intentional stalls, the major objective is not to learn how to stall a glider, but rather to learn how to recognize an approaching stall and take prompt corrective action. The recovery actions involve a coordinated recovery.

First, at the indication of a stall, the pilot should immediately lower the pitch attitude and AOA by releasing the back-elevator pressure or by moving the elevator control forward. This lowers the nose and returns the wing to an effective AOA. The amount of elevator control pressure or movement to use depends on the design of the glider, the severity of the stall, and proximity to the ground. In some gliders, a moderate movement of the elevator control—perhaps slightly forward of neutral—suffices, while others may require a forcible push to the full forward position. However, an excessive negative load on the wings caused by excessive forward movement of the elevator may impede, rather than hasten, the stall recovery. The object is to reduce the AOA sufficiently to allow the wing to regain lift. [*Figure 7-41*]

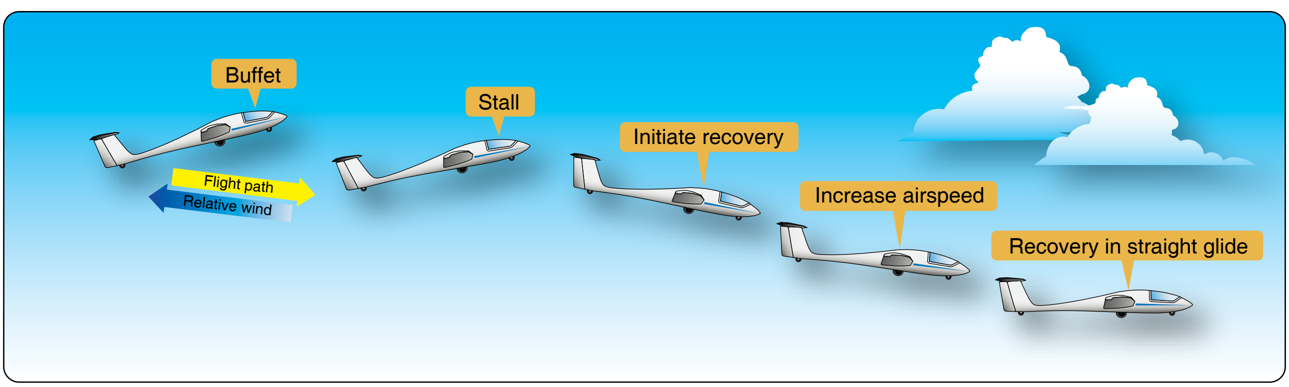

Figure 7-41. *Stall recovery.*

When practicing stalls in a powered glider, the pilot should experience the stall and recovery with and without the engine running. In a stall with power available, the pilot should smoothly and promptly apply maximum allowable power during the stall recovery while lowering the pitch attitude to increase the self-launching glider's speed and assist in reducing the AOA. The applied power reduces the loss of altitude. Maximum allowable power applied at the instant of a stall does not usually cause overspeeding of an engine equipped with a fixed-pitch propeller, due to the heavy air load imposed on the propeller at low airspeeds. However, the pilot may reduce the power as airspeed increases so the airspeed or rpm does not become excessive.

Introduction to stalls should consist of approaches to stalls with recovery initiated at the first airframe buffet or when the pilot recognizes partial loss of control. Using this method, pilots become familiar with the initial indications of an approaching stall without fully stalling the glider. Whether in an unpowered or powered glider, stall recovery occurs by reducing the angle of attack, leveling the wings with coordinated control inputs, and returning to straight flight. Whenever practicing stalls while turning, the pilot should maintain a constant bank angle until the stall occurs.

Stalls in most gliders move progressively outward from the wing roots (where the wing attaches to the fuselage) to the wingtips. This occurs because the wings have a smaller angle of incidence at the tips than at the wing roots. When an exceedance of the critical angle of attack results in a stall, the outer part of the wing can retain some aerodynamic effectiveness. During recovery from a stall, the return of lift begins at the tips and progresses toward the roots, thus giving the ailerons authority to level the wings.

Using the ailerons requires finesse to avoid an aggravated stall condition. For example, if the right wing drops during the stall and the pilot uses excessive aileron control to the left to raise the wing, the aileron that deflects downward on the right wing would change the camber of that portion of the wing. The increased AOA could cause the wing to stall at the tip. The increase in drag created by the high AOA on that wing might cause the airplane to yaw in that direction. This adverse yaw could result in a spin unless the pilot maintains directional control with rudder or reduces aileron deflection.

Even with application of excessive aileron pressure, a spin does not occur if the pilot maintains directional (yaw) control using timely application of coordinated rudder pressure. Therefore, the pilot should use rudder properly during both entry and recovery from a stall. The rudder in stall recovery counteracts any tendency of the glider to yaw. A pilot using correct stall recovery technique decreases the pitch attitude by applying forward elevator pressure to reduce the AOA and simultaneously maintains directional control with coordinated use of the aileron and rudder.

Advanced stalls include secondary, accelerated, and crossed-control stalls. These stalls expand a pilot's stall/spin awareness.

Secondary Stalls

A secondary stall occurs during a recovery from a preceding stall. It may occur when the pilot attempts to complete a stall recovery with abrupt control input or before the glider has regained sufficient flying speed, which results in a repeated stall. When this stall occurs, the pilot should release back-elevator pressure as in a normal stall recovery.

Accelerated Stalls

Actual accelerated stalls occur most frequently during turns in the traffic pattern close to the ground while maneuvering the glider for the approach. A glider pilot should recognize signs of an imminent accelerated stall and take prompt action to prevent a completely stalled condition to avoid loss of altitude or a spin.

Performing intentional accelerated stalls can show the pilot how these stalls occur, enhance pilot recognition of conditions that can cause a stall, and reinforce timely and proper recovery action. During training at a safe altitude, pilots should learn how to recover at the first indication of a stall or immediately after the stall occurs.

A glider at a given weight consistently stalls at the same indicated airspeed in unaccelerated 1G flight. However, the glider stalls at a higher indicated airspeed when the pilot imposes a maneuvering load as in a steep turn or pull-up. These maneuvers rely on an increased angle of attack to generate the lift used to change the path of the glider. If the demand for additional lift exceeds the critical angle of attack, an accelerated stall occurs and could surprise a pilot. Depending on the wing configuration and quality of coordination, one wing may stall prior to the other wing. If the wings have a slight or pronounced sweep, one wing can rapidly develop more lift than the other, and a spin could occur before the pilot can react. For this reason, pilots should avoid turning too tightly in the traffic pattern to prevent exceeding the critical angle of attack and any resulting accelerated stall at a low altitude.

Pilots should not perform accelerated maneuver stalls in any glider if the GFM/POH prohibits this maneuver. If permitted, training for this maneuver occurs with a bank of approximately 45° and never at a speed greater than the manufacturer's recommended airspeed for the maneuver or the design maneuvering speed specified for the glider. At the design maneuvering speed, the glider will stall before application of full aerodynamic control can exceed the glider's limit load factor. The stall unloads the wings, cuts off the acceleration, and prevents structural damage.

A glider slipping toward the inside of the turn at the time the stall occurs tends to roll rapidly toward the outside of the turn as the nose pitches down and the outside wing stalls first. A glider skidding toward the outside of the turn tends to roll to the inside of the turn because the inside wing stalls first. During a stall in a coordinated turn, the glider's nose pitches away from the pilot just as it does in wings-level stall since both wings stall simultaneously. The configuration of the wings has a strong influence on exactly how a glider reacts to different airflows. A pilot should fly the specific glider into these situations at a safe altitude to determine how the glider will react. This training should condition the pilot to avoid an accelerated stall that could result in an accident.

As with any deliberate stall, the area should be clear of other aircraft. From straight flight at maneuvering speed or less, the pilot should roll the glider into a steep banked (45° maximum) turn and gradually apply back-elevator pressure. After establishing the bank, the pilot smoothly and steadily increases back-elevator pressure. The resulting apparent centrifugal force pushes the pilot's body down in the seat, increases the wing loading, and decreases the airspeed. The pilot should firmly increase back-elevator pressure until a definite stall occurs.

When the glider stalls, recovery involves the prompt release of back-elevator pressure. In an uncoordinated turn, one wing may tend to drop suddenly, causing the glider to roll in that direction. If this occurs, the pilot should lower the nose and use coordinated control pressure to return glider to wings-level, straight flight.

An accelerated stall could occur any time the pilot applies excessive back-elevator pressure or increases the AOA too rapidly. Although demonstrated from a steep turn, the maneuver allows the pilot to experience accelerated stall characteristics and develop the ability to recover instinctively at the onset of a stall at any other-than-normal stall speed or flight attitude.

Crossed-Control Stalls

A crossed-control stall demonstration maneuver shows the effect of improper control technique and emphasizes the importance of coordinated control pressures whenever making turns. This type of stall occurs with the controls crossed—aileron pressure applied in one direction and rudder pressure in the opposite direction while exceeding the critical AOA. [*Figure 7-42*]

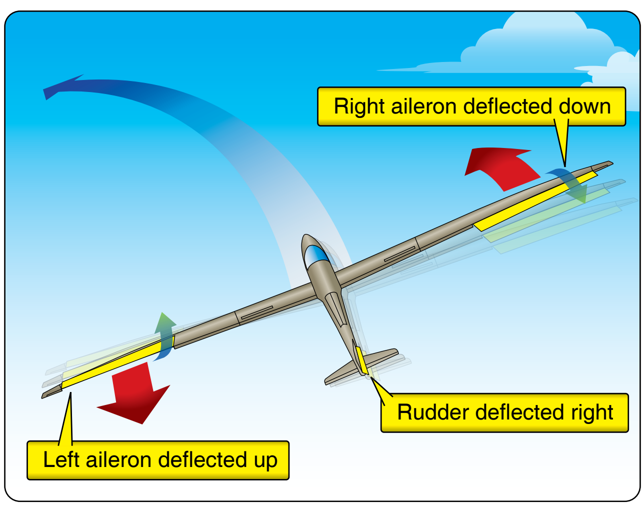

Figure 7-42. *Demonstrating a crossed-control approach to a stall at altitude.*

This stall most commonly occurs during a poorly planned and executed base-to-final turn when overshooting the centerline of the runway during the turn. Normally, the pilot should correct by increasing the rate of turn using coordinated aileron and rudder. At the relatively low altitude of a base-to-final approach turn, improperly trained pilots sometimes fear steepening the bank to increase the rate of turn and incorrectly use excessive rudder pressure to yaw the airplane.

The addition of rudder pressure on the inside of the turn causes the speed of the outer wing to increase, creating greater lift on that wing. To keep that wing from rising and to maintain a constant angle of bank, the pilot applies opposite aileron pressure. The added inside rudder pressure also causes the nose to lower in relation to the horizon. Consequently, the pilot adds additional back-elevator pressure to maintain a constant pitch attitude. The resulting turn uses rudder applied in one direction, aileron in the opposite direction, and excessive back-elevator pressure—a pronounced crossed-control condition. The down aileron on the inside of the turn helps drag that wing back, slowing it and decreasing its lift. This further causes the glider to roll. The roll may be so fast that it is possible the bank will be vertical or past vertical before the pilot can stop and reverse it.

The demonstration of the maneuver should occur at a safe altitude because of the possible extreme nose-down attitude and loss of altitude that may result. Before demonstrating this stall, the pilot should clear the area for other air traffic. As the pilot establishes the gliding attitude and airspeed, the glider should be retrimmed. With the glide established, the pilot rolls the glider into a medium banked turn to simulate a final approach turn that would overshoot the centerline of the runway. During the turn, the pilot applies excessive rudder pressure in the direction of the turn while holding bank constant with opposite aileron pressure. At the same time, increased back-elevator pressure keeps the nose from lowering.

All these control pressures increase until the glider stalls. When the stall occurs, releasing the control pressures and simultaneously decreasing the AOA initiates the recovery. In a crossed-control stall, the glider often stalls with little warning. The nose may pitch down, the inside wing may suddenly drop, and the glider may continue to roll to an inverted position. This is usually the beginning of a spin.

The pilot should recover before the glider enters an abnormal attitude (vertical spiral or spin) by returning to wings-level, straight flight using coordinated control inputs. The pilot should recognize imminent stall and take immediate action to prevent a completely stalled condition. This type of stall during an actual approach to a landing would likely result in ground contact before recovery.

Common Errors

Common errors during advanced stalls include:

- Improper pitch and bank control during straight-ahead and turning stalls.
- Rough or uncoordinated control procedures.
- Failure to recognize the first indications of a stall.
- Premature recovery when demonstrating a full stall.
- Poor recognition and recovery procedures.
- Excessive altitude loss, excessive airspeed, or encountering a secondary stall during recovery.

Chapter Summary

Regardless of the launch method, pilots and ground personnel should have the ability to communicate effectively. This not only includes knowing appropriate signals, but also knowing when to use them. Briefing of all personnel before takeoff enhances the safety of a glider operation. Takeoffs normally occur with the assistance of a wing runner; however, the chapter also discusses unassisted takeoff techniques that experienced pilots may use. The chapter discusses various maneuvers including level glides, turns, steep turns, release procedures, slack line avoidance and recovery, and boxing the wake. A pilot can discern turn coordination using a yaw string or inclinometer, and the chapter gives practical advice regarding the use of these instruments when adjusting from a slip or skid. Pilots should understand the traffic pattern procedures for every field they use. A minimum altitude for the initial point (IP) of the traffic pattern should allow the glider pilot to maneuver to the landing field and make a successful landing in a variety of conditions including normal, crosswind, and downwind. A pilot should know how to make a stable final approach to an aiming point, use drag devices and slips to control the descent angle, and land in a crosswind with no side load. Pilots should recognize various stalls and know how to avoid conditions that could result in any unintentional stall. Flight at minimum controllable airspeed and stall training at a safe altitude build pilot awareness of and resistance to unsafe operating conditions.